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Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement, Volume 1, Appendix B

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Volume 1
Appendix B

Idaho National Engineering Laboratory Spent Nuclear Fuel Management Program

April 1995

U.S. Department of Energy
Office of Environmental Management
Idaho Operations Office

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1. INTRODUCTION

The U.S. Department of Energy (DOE) has prepared the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement* (SNF and INEL EIS) to assist its management in making two decisions. The first decision, which is programmatic, is to determine the management program for DOE spent nuclear fuel. The second decision is on the future direction of environmental restoration, waste management, and spent nuclear fuel management activities at the Idaho National Engineering Laboratory.

Volume 1 of the EIS, which supports the programmatic decision, considers the effects of spent nuclear fuel management on the quality of the human and natural environment for planning years 1995 through 2035. DOE has derived the information and analysis results in Volume 1 from several site-specific appendixes. Volume 2 of the EIS, which supports the INEL-specific decision, describes environmental impacts for various environmental restoration, waste management, and spent nuclear fuel management alternatives for planning years 1995 through 2005.

This Appendix B to Volume 1 considers the impacts on the INEL environment of the implementation of various DOE-wide spent nuclear fuel management alternatives. The Naval Nuclear Propulsion Program, which is a joint Navy/DOE program, is responsible for spent naval nuclear fuel examination at the INEL. For this appendix, naval fuel that has been examined at the Naval Reactors Facility and turned over to DOE for storage is termed naval-type fuel. This appendix evaluates the management of DOE spent nuclear fuel including naval-type fuel. Naval spent nuclear fuel examination is addressed in Appendix D; Section 5.16 of this appendix includes relevant environmental consequences from Appendix D.

In addition to this introduction, Appendix B contains the following chapters:

- Chapter 2 - Background: Describes INEL spent nuclear fuel facilities, the regulatory framework for spent nuclear fuel management at the INEL, and the INEL spent nuclear fuel management program.

- Chapter 3 - Spent Nuclear Fuel Management Alternatives: Describes the DOE-wide spent nuclear fuel management alternatives as the INEL would implement them, and provides a summary comparison of potential environmental consequences for each alternative, as described in Chapter 5.

- Chapter 4 - Affected Environment: Describes the INEL site and the surrounding environment that DOE spent nuclear fuel management actions could affect.

- Chapter 5 - Environmental Consequences: Provides the results of environmental consequence analyses for each spent nuclear fuel management alternative.

- Chapter 6 - References

Volume 1 contains a list of acronyms and abbreviations and a glossary that is applicable to this appendix.

2. BACKGROUND

This chapter contains an overview of the Idaho National Engineering Laboratory (INEL) facilities and historic events related to spent nuclear fuel, a description of the regulatory framework for the actions evaluated in this document, and an overview of the current spent nuclear fuel management program at the INEL.

2.1 Overview

The following sections provide a general overview of the INEL including its history, current activities, and mission as they relate to spent nuclear fuel management and future decisions.

2.1.1 History of Spent Nuclear Fuel Activities

The U.S. Atomic Energy Commission, a predecessor of the U.S. Department of Energy (DOE), established the INEL, formerly the National Reactor Testing Station, to build, test, and operate various types of nuclear reactors, support plants, and associated equipment. Since its establishment in 1949 (see Table 2-1), DOE and its predecessor agencies have built 52 reactors at the INEL. The major DOE programs at the site have included test irradiation services, uranium recovery from highly enriched spent fuels, calcination of liquid radioactive waste, light-water-cooled reactor safety testing and research, operation of research reactors, environmental restoration, and storage and surveillance of solid transuranic wastes. In support of the DOE reactor research program and as part of the spent nuclear fuel reprocessing program, the INEL has received spent nuclear fuel from more than 30 offsite sources, including naval reactors, university reactors, commercial reactors, and DOE research reactors, as well as fuels fabricated in the United States and irradiated in foreign reactors (DOE 1993).

The Experimental Breeder Reactor-I, now a National Historic Landmark, maintains a key place in the history of nuclear power in the United States. In December 1951, this reactor generated the first usable electricity from a nuclear reactor. The Experimental Breeder Reactor-I also demonstrated that a nuclear reactor could actually produce more fuel than it consumes.

Of special significance to spent nuclear fuel is the history of the Idaho Chemical Processing Plant. From 1953 to 1992, this plant recovered usable uranium from spent nuclear fuel from United States government reactors. The plant operated for 39 years as a full-scale production facility. But in

Table 2-1. INEL spent nuclear fuel history.

Year	Event
1949	National Reactor Testing Station established
1951	Site reactor first to generate electricity from nuclear fission
1953	ICPP[a] began operation
1953	Test of first submarine nuclear reactor
1957	Expended Core Facility constructed
1965	DOE contract with Public Service Company of Colorado (Fort St. Vrain)
1974	Site became Idaho National Engineering Laboratory
1980	DOE contracted to receive Public Service Company of Colorado (Fort St. Vrain) spent nuclear fuel
1992	Decision to discontinue reprocessing of spent nuclear fuel at ICPP[a] announced
1992	DOE creates Office of Spent Fuel Management
1993	Court order of June 28, 1993 issued

a. ICPP = Idaho Chemical Processing Plant.

April 1992, DOE decided to phase out reprocessing for material recovery, resulting in the shutdown of the reprocessing operation.

Spent naval nuclear fuel handling at the Naval Reactors Facility originated in 1957 with the construction of the Expended Core Facility. The original building contained a water pit and shielded cells, which are connected to the water pit by transfer tunnels. The Expended Core Facility examines spent nuclear fuel from operating naval ships and from prototype naval reactors. The examinations support research and development for naval fuel quality improvement. Over the years, the Navy made additions and improvements at the Naval Reactors Facility site, including the construction and operation of three prototype reactors and facilities for training naval nuclear powerplant operators. The Naval Nuclear Propulsion Program is placing the prototype reactors, which have reached the ends of their useful lives, in layup. All training is expected to end before DOE issues the Record of Decision for this Environmental Impact Statement (EIS). Expended Core Facility activities are continuing. Appendix D describes the Naval Reactors Facility in more detail.

In 1965 the United States entered into a contract with Public Service Company of Colorado, with which the United States agreed to lease special nuclear material to Public Service Company of

Colorado for fuel at the Fort St. Vrain Nuclear Power Plant. In 1980, the United States and Public Service Company of Colorado modified the 1965 contract, requiring DOE to accept returned Fort St. Vrain spent nuclear fuel at the INEL. From 1980 to 1986, Public Service Company of Colorado made approximately 120 shipments of Fort St. Vrain spent nuclear fuel to the INEL.

In 1974 the National Reactor Testing Station became the Idaho National Engineering Laboratory. The INEL mission broadened to include research and engineering for nonnuclear programs and environmental restoration and waste management activities.

In the early 1980s, pursuant to the West Valley Demonstration Project Act (42 USC 2021a) and a court order, DOE agreed to accept 125 special case commercial reactor spent nuclear fuel assemblies located at the state-owned Western New York Nuclear Service Center. DOE began a project to demonstrate the viability of a transportable spent nuclear fuel storage cask, with the intention of shipping the fuel to the INEL. Based on this, New York State Energy Research and Development Authority, which has jurisdiction over the center, has allowed continued storage until DOE obtained U.S. Nuclear Regulatory Commission Certificates of Compliance, which have been issued. The fuel remains at West Valley awaiting the Record of Decision for this EIS.

In addition to the naval and INEL-generated fuel on the site, some special-case spent nuclear fuel, such as fuel from university reactors, has been shipped directly to the Idaho Chemical Processing Plant for storage. Damaged fuel from the 1979 Three Mile Island accident was shipped directly to Test Area North for examination and storage as part of a research mission.

In 1990, DOE issued an Environmental Assessment and Finding of No Significant Impact for Public Service Company of Colorado shipments of Fort St. Vrain spent nuclear fuel to the INEL. The State of Idaho challenged the adequacy of the Environmental Assessment and, in June 1993, the United States District Court for the District of Idaho found for the State and ordered DOE to prepare this EIS. A DOE appeal of the order resulted in a December 1993 amendment that governs the DOE schedule and obligation for preparing the EIS.

2.1.2 Current Activities at Spent Nuclear Fuel-Related Facilities

Six major facility areas at the INEL (Figure 2-1) store spent nuclear fuel: Argonne National Laboratory - West, Idaho Chemical Processing Plant, Naval Reactors Facility, Power Burst Facility,

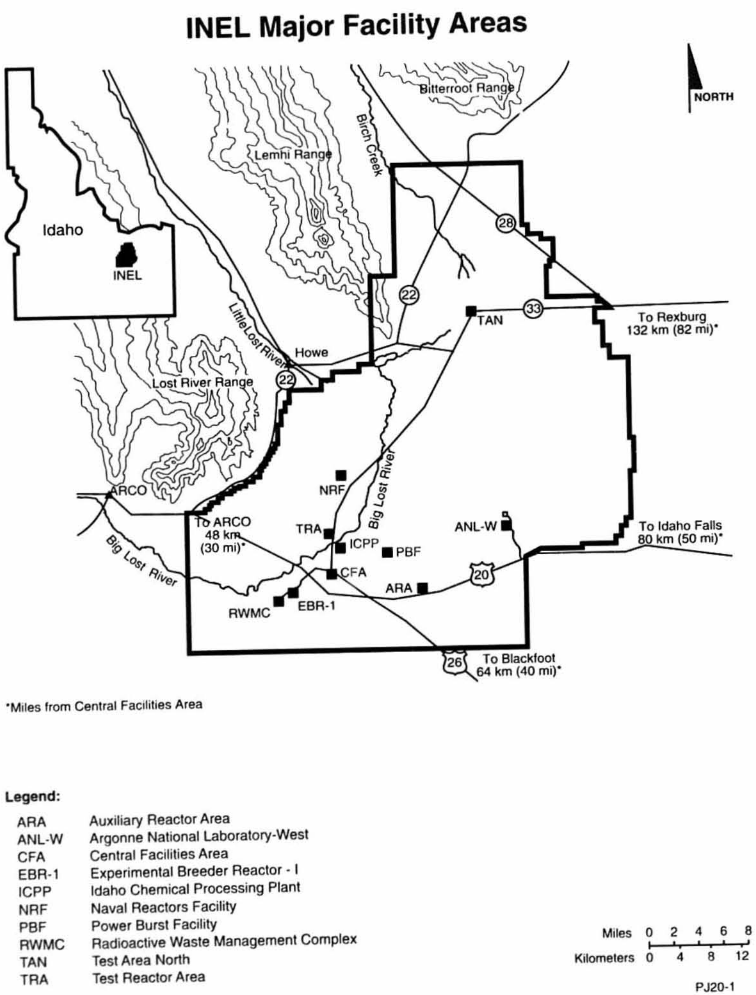


Figure 2-1. Major facility areas located at the Idaho National Engineering Laboratory site.

Test Area North, and Test Reactor Area. Spent fuel at the INEL is kept in a variety of dry and wet configurations. The total amount of spent nuclear fuel at the INEL accounts for about 10 percent (by weight of heavy metal) of the spent nuclear fuel in the DOE complex (DOE 1993).

Table 2-2 lists the primary INEL spent nuclear fuel storage facilities, the types of fuel in storage, and the storage configurations. Figure 2-2 indicates the relative proportion of fuel at these facilities. The number and variety of wet and dry storage configurations currently in use at the INEL is largely the result of the different purposes for the facilities (e.g., at-reactor storage, storage research and development, reprocessing, and fuel research and development). The condition of the spent nuclear fuel in storage is generally good with the notable exception of the fuel in the Underwater Fuel Storage Facility (CPP-603). The following paragraphs briefly describe each primary facility area that manages spent nuclear fuel.

The Argonne National Laboratory - West generates spent nuclear fuel as a result of research and development activities related to advanced reactor design. DOE has brought small quantities of spent nuclear fuel from other reactors to this facility to support these activities. Reactors at Argonne National Laboratory - West are the Experimental Breeder Reactor II, the Transient Reactor Test Facility, the Zero Power Physics Reactor, and the Neutron Radiography Reactor. Storage facilities include both wet (including molten sodium) and dry configurations.

The Idaho Chemical Processing Plant historically received spent nuclear fuel from many onsite and offsite reactors for reprocessing (i.e., the recovery of uranium for reuse). However, DOE decided to phase out reprocessing activities in 1992. The new mission for this facility area is receipt and storage, plus research and development of technologies in support of the disposition of spent nuclear fuel. The Idaho Chemical Processing Plant stores virtually all types of spent nuclear fuel except production reactor fuel [i.e., fuel from Hanford Site and Savannah River Site (SRS) production reactors]. It stores nonproduction aluminum-based spent nuclear fuel. This facility uses both wet and dry storage configurations.

The Naval Reactors Facility includes the Expended Core Facility, which receives and examines naval spent nuclear fuel to support fuel development and performance analyses. In addition, the Expended Core Facility removes structural support material from fuel assemblies before the transfer of the fuel portion to the Idaho Chemical Processing Plant for interim storage.

Table 2-2. Major INEL spent nuclear fuel storage facilities.

Facility[a]	Storage Type[b]	Fuel Type[c] 1	2	3	4	5	6a	6b	6c
Argonne National Laboratory - West									
Experimental Breeder Reactor II	Liquid sodium						•		
Hot Fuel Examination Facility	Dry						•		
Neutron Radiography Reactor	Wet						•		
Radioactive Scrap and Waste Facility	Dry						•		
Transient Reactor Test Facility	Dry							•	
Idaho Chemical Processing Plant									
Underwater Fuel Storage Facility[d]	Wet	•	•				•	•	
Irradiated Fuel Storage Facility	Dry				•				
Fuel Storage Area/Fluorinel Dissolution Process Cell	Wet	•	•				•	•	
Underground Storage Facility	Dry				•				
Naval Reactors Facility									
Expended Core Facility	Wet	•				•			
Expended Core Facility Rail Siding	Dry	•							
Power Burst Facility									
Power Burst Facility Storage Canal	Wet						•		
Test Reactor Area									
Materials Test Reactor Canal	Wet					•		•	
Advanced Reactivity Measurement Facility	Wet		•						
Coupled Fast Reactivity Measurement Facility	Wet		•						
Advanced Test Reactor Canal	Wet		•						
Test Area North									
Test Area North Pool	Wet					•			
Test Area North Pad	Dry					•			

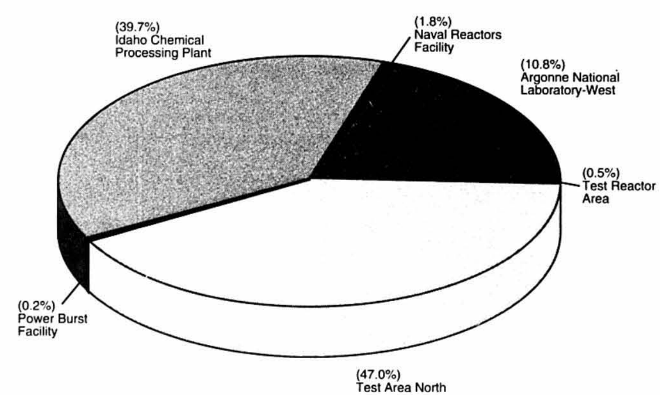
a. This table lists the major spent fuel storage facilities. Other facilities (e.g., laboratories) might periodically contain small quantities of spent nuclear fuel.

b. Wet storage involves water-filled pools. Dry storage involves a variety of configurations (e.g., casks, wells, buildings).

c. The spent fuel types are as follows:
1. Naval-type fuel
2. Savannah River Site production fuels and other aluminum-clad fuels
3. Hanford Site production fuels
4. Graphite fuels
5. Special case commercial fuels

6a. Experimental reactors - stainless steel-clad fuels
6b. Experimental reactors - zirconium-clad fuels
6c. Experimental reactors - other fuel configurations

d. Spent nuclear fuel storage at this facility will cease by December 31, 2000, as part of an agreement between DOE and the State of Idaho.



Note: Percentages represent metric tons of heavy metal of spent nuclear fuel

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Figure 2-2. Existing (1995) distribution of INEL SNF.

The Power Burst Facility reactor was placed in operational standby in 1992. A limited amount of spent nuclear fuel from this facility remains in wet storage, in a storage pool that is in good condition, but it is small and uneconomical to use. DOE plans to remove the fuel from this facility by 1996.

DOE has used Test Area North for commercial reactor fuel research. The large Test Area North Hot Shop and Hot Cells have supported the Loss of Fluid Test and commercial nuclear fuel testing, including dry cask storage demonstration. Test Area North stores special case commercial fuel (including Three Mile Island Unit 2 core debris) and DOE experimental fuel similar to commercial nuclear fuel.

Test Reactor Area has historically operated a number of test reactors, but the Advanced Test Reactor and its associated Critical Facility are the only reactors now operating. Most spent nuclear fuel at this area is associated with the Test Reactor Area reactors, which utilized aluminum-based fuels. In addition, DOE stores small amounts of special case commercial, foreign, and Power Burst Facility spent nuclear fuel at Test Reactor Area in the Materials Test Reactor basin. All spent nuclear fuel in storage at the Test Reactor Area is in water-filled pools (DOE 1993).

2.1.3 Spent Nuclear Fuel Mission

The INEL spent nuclear fuel mission is to manage DOE-owned spent fuel cost-effectively and in a way that protects the safety of INEL workers, the public, and the environment. As the lead laboratory for the DOE Spent Nuclear Fuel Program, the INEL provides support to the Office of Spent Fuel Management and coordinates the development of an integrated program for DOE.

The main focus of near-term activities is the accurate quantification and characterization of DOE-owned spent nuclear fuel, identification of spent nuclear fuel management facilities and their conditions, identification of safe interim storage for existing and new spent nuclear fuel, and identification of technologies and requirements to place DOE spent nuclear fuel in safe interim storage. Long-term activities include the development of final waste acceptance criteria requirements and stabilization technologies for alternate fuel disposition, construction of facilities to stabilize fuel to meet waste disposal requirements, processing of the fuel to a final waste form, and transportation of the waste form for disposition.

2.2 Regulatory Framework for Spent Nuclear Fuel Management

This section summarizes State of Idaho laws and regulations that apply to spent nuclear fuel management at the INEL. Volume 1, Section 7.2, provides summary information for Federal laws and regulations, Executive Orders, and DOE Orders. Volume 2, Chapter 2, provides information on National Environmental Policy Act reviews related to site-specific decisions that have potential environmental impacts. Volume 2, Chapter 7, provides information on regulatory permits that the INEL holds or for which it has applied.

The Idaho Environmental Protection and Health Act (Idaho Code, Title 39, Chapter 101 et seq.) establishes general provisions for the protection of the environment and public health. The Act created the Idaho Department of Health and Welfare and its Division of Environmental Quality, thereby consolidating all state public health and environmental protection activities in one department. The Act authorizes the Department to promulgate standards, rules, and regulations related to water and air quality, noise reduction, and solid waste disposal; and grants authority to issue required permits, collect fees, establish compliance schedules, and review plans for the construction of sewage and public water treatment and disposal facilities.

The Idaho Water Pollution Control Act (Idaho Code, Title 39, Chapter 36) authorizes the Department of Health and Welfare to protect the waters of Idaho. This law contains general language on the prevention of water pollution and the provision of financial assistance to municipalities.

The Idaho Department of Health and Welfare is also responsible for the enforcement and implementation of the Hazardous Waste Management Act of 1983, as amended (Idaho Code, Title 39, Chapter 44), which provides for the protection of health and the environment from the effects of improper or unsafe management of hazardous wastes and for the establishment of a tracking or manifesting system for these wastes. This program is intended to be consistent with, and not more stringent than, the Federal regulations established under the Resource Conservation and Recovery Act (RCRA). At this time, Idaho has primacy over hazardous and mixed waste regulations promulgated through July 1, 1990, by the U.S. Environmental Protection Agency. The Hazardous Waste Management Act sets forth requirements for the development of plans that address the identification of hazardous wastes; unauthorized treatment, storage, release, use, or disposal of these wastes; and permit requirements for hazardous waste facilities. Under the authority of this Act, the Idaho Department of

Health and Welfare has promulgated rules and regulations on the transportation, monitoring, reporting, and record keeping of hazardous wastes.

Several INEL facilities have air quality permits from the State, and operate in compliance with permit conditions. Permit applications are currently pending with the State for proposed new or modified emission sources. In April 1991 DOE submitted an inventory of all potential INEL radioactive and criteria pollutant emission sources to the State. The inventory contains the information necessary for the State to issue the INEL a Permit to Operate.

The Idaho Department of Health and Welfare, Division of Environmental Quality, Air Quality Bureau, conducts annual inspections of the INEL to determine if the operating portions of the site are in compliance with the *Rules for the Control of Air Pollution in Idaho*. The most recent inspections were in January 1994. In addition, pursuant to 40 CFR Part 61.94(H), DOE submits to the State an annual report documenting compliance with National Emission Standards for Hazardous Air Pollutants at the INEL.

2.3 Spent Nuclear Fuel Management Program at the INEL

In 1992 the Secretary of Energy directed the Assistant Secretary for Environmental Restoration and Waste Management to develop an integrated, long-term spent nuclear fuel management program. In response to this request, DOE created the Office of Spent Fuel Management (EM-37). This office, which has strategic programmatic responsibilities, has designated the INEL as the program support organization for the DOE Spent Nuclear Fuel Program. In this role, the INEL provides technical support to the Office of Spent Fuel Management and develops site communication and integration for the national program.

As identified in the *Spent Fuel Working Group Report on Storage of the Department's Spent Nuclear Fuel and Other Reactor Irradiated Nuclear Materials and Their Environmental, Safety and Health Vulnerabilities*, Volume I (DOE 1993), some of the current storage facilities at the INEL are inadequate for extended interim storage, and additional storage facilities or modifications might be necessary. In February 1994, DOE issued, *Plan of Action to Resolve Spent Nuclear Fuel Vulnerabilities, Phase I* (DOE 1994a), followed by a Phase II Plan in April 1994 (DOE 1994b) and a Phase III Plan in October 1994 (DOE 1994c), which identified specific corrective actions to address the spent nuclear fuel vulnerabilities. At the INEL, many of the corrective actions have been

completed or are currently underway. The spent nuclear fuel storage pools at Test Area North, Power Burst Facility, and the Underwater Fuel Storage Facility do not comply with new facility regulatory requirements. The INEL plans to move spent nuclear fuel from the CPP-603 Underwater Fuel Storage Facility by December 31, 2000. To stabilize this fuel for storage, the INEL also plans to install canning equipment in the Irradiated Fuel Storage Facility hot cell. This equipment is scheduled for operation by late 1995. To the extent of its existing capability, DOE could consolidate spent nuclear fuel at the Power Burst Facility, the Idaho Chemical Processing Plant, and the Test Area North at the Idaho Chemical Processing Plant as a result of implementing the management alternatives described in Chapter 3. These activities and other planned actions for which National Environmental Policy Act review will be completed before the Record of Decision of this EIS were analyzed under the No-Action Alternative (see Chapter 3).

Each of the specific INEL spent nuclear fuel Plan of Action projects could result in emissions, worker exposures, and other potential environmental impacts. The potential environmental impacts that could result from each project or corrective action item were not analyzed individually but were collectively enveloped by the spent nuclear fuel management activities reported and analyzed for each alternative. Successful completion of the corrective actions would significantly reduce the near-term environmental, safety, and health risks associated with spent fuel storage at INEL.

The INEL has provided support in the development of dry at-reactor storage of special case commercial spent nuclear fuel in accordance with the requirements of the Nuclear Waste Policy Act of 1982 and its 1987 amendments. Dry-storage demonstrations and research at the INEL contributed to the granting of NRC licenses to several utilities for the construction and operation of dry-storage facilities at reactor sites. Research at these facilities is demonstrating the technical feasibility and the economics of adding dry storage capacity in metal or concrete spent fuel storage casks at reactor sites.

3. SPENT NUCLEAR FUEL MANAGEMENT ALTERNATIVES

Chapter 3 describes the alternatives for spent nuclear fuel management as they relate to the Idaho National Engineering Laboratory (INEL) and summarizes and compares potential environmental consequences for each alternative. Chapter 5 contains full descriptions of the consequences of implementing the alternatives.

3.1 Description of Alternatives

DOE has identified five spent nuclear fuel management alternatives:

Alternative 1 - No Action

Alternative 2 - Decentralization (2a, 2b, and 2c)

Alternative 3 - 1992/1993 Planning Basis

Alternative 4 - Regionalization (4a and 4b)

Alternative 5 - Centralization (5a and 5b)

Table 3-1 summarizes the actions that would result from the implementation of these alternatives at the INEL. For each alternative, this table summarizes the proposed transportation, stabilization, storage, research and development, and naval-type fuel examination activities. For alternatives 2, 4, and 5, it identifies a number of options.

The analysis of each alternative considers, as appropriate, existing and projected spent nuclear fuel inventories, existing spent nuclear fuel wet and dry storage facilities, the construction of storage facilities and associated stabilization facilities to achieve interim management objectives, and the relocation of the spent nuclear fuel as appropriate to proposed interim storage facilities.

Table 2-2 lists existing spent nuclear fuel storage facilities with associated type(s) of storage and fuel. Table 3-2 lists the potential facilities and projects required for specific alternatives. DOE has based the potential environmental consequences for each alternative on the existing and proposed facilities and projects listed in Tables 2-2 and 3-2, respectively.

Table 3-1. Summary of spent nuclear fuel management alternatives at the Idaho National Engineering Laboratory.[a]

	Alternative	Description	Transportation	Stabilization	Storage	Research and Development	Naval-Type Fuel Examination
1.	No Action	Minimum actions necessary for continued safe/secure management of SNF.	No shipment to or from the INEL after transition period. Onsite transport of SNF limited to that required for safe storage. Receipt of naval-type SNF during transition period.	Limited to those minimum actions required to store SNF safely.	Minimum facility upgrade/replacement to support safe storage. Replacement dry storage facility for Test Area North storage pool.	Existing R&D activities for SNF management would continue.	Shipment to INEL and examinations after a transition period would be phased out.
2.	Decentralization	SNF would be stored close to existing locations with limited shipments to DOE facilities.	Same as Alternative 1 plus: · Receipt of non-DOE domestic and foreign research SNF · Receipt of naval-type fuels for examination and reshipment (option 2c) · Onsite SNF transfer for consolidation	Same as Alternative 1	Same as Alternative 1	Treatment technology and R&D activities for DOE SNF management and disposal permitted.	Three options: · Options 2a and 2b are the same as for Alternative 1 · Option 2c would enable the continued receipt of naval-type fuels for inspection at the ECF and a return to originating shipyards. The ECF Dry Cell Construction project would be completed.
3.	1992/1993 Planning Basis	DOE 1992, 1993 planning basis for DOE and naval-type SNF management.	· Receipt of some foreign, Fort St. Vrain, West Valley, and non-DOE domestic research SNF. · Onsite transfer. · Receipt of naval-type SNF for examination at the ECF and transfer to the ICPP for interim storage.	Stabilization as planned: new canning and characterization facility required.	Replacement dry storage facility for Test Area North storage pool. New dry fuel storage facility and increased rack capacity in storage pools.	Same as Alternative 2 plus: Electrometallurgical Process Demonstration Project at ANL-W	ECF continues operation as planned. The ECF Dry Cell Construction would be completed.

Table 3-1. (continued).

Alternative		Description	Transportation	Stabilization	Storage	Research and Development	Naval Type Fuel Examination
4a.	Regionalization by Fuel Type	Existing and new SNF redistribution based on similarity of fuel type. All SNF in DOE complex would be managed at Hanford Site, INEL, or Savannah River Site.	Distribute existing and projected SNF to the INEL based primarily on fuel type.	SNF to be retained at the INEL would be stabilized as planned; for SNF to be shipped to regional sites, any stabilization beyond that required for transportation would be performed at the regional site.	Same as Alternative 3	Same as Alternative 3	Same as Alternative 3
4b(1).	Regionalization by Geography (INEL)	Existing and projected Western DOE and naval-type SNF would be managed at the INEL.	Shipment of all Western SNF in DOE complex to the INEL.	Sites shipping SNF to INEL would stabilize for purpose of transportation; any further stabilization would be performed at the INEL.	Construction of new facilities for SNF storage.	Same as Alternative 3	Same as Alternative 3
4b(2).	Regionalization by Geography (Elsewhere)	Existing and projected Western DOE and naval-type SNF would be managed at Hanford Site or Nevada Test Site.	Existing INEL SNF shipped offsite to selected Western Regionalization site.	SNF at the INEL would be stabilized at a canning, characterization, and shipping facility prior to shipment offsite; other SNF would be stabilized as required at the selected Regionalization site.	Phaseout of all SNF storage facilities.	Phaseout of all R&D activities at the INEL except the Electrometallurgical Process Demonstration Project at ANL-W.	Same as Alternative 1
5a.	Centralization at Other DOE Sites	Existing and projected DOE and naval-type SNF would be managed at Hanford Site, Savannah River Site, Oak Ridge, or Nevada Test Site.	Existing INEL SNF shipped offsite to selected centralization site.	SNF at the INEL would be stabilized at a canning, characterization, and shipping facility prior to shipment offsite; other SNF would be stabilized as required at the selected Centralization site.	Phaseout of all SNF storage facilities.	Phaseout of all R&D activities at the INEL except the Electrometallurgical Process Demonstration Project at ANL-W.	Same as Alternative 1

Table 3-1. (continued).

	Alternative	Description	Transportation	Stabilization	Storage	Research and Development	Naval Type Fuel Examination
5b.	Centralization at the INEL	Existing and projected DOE and naval-type SNF would be managed at the INEL.	Shipment of all SNF in DOE complex to the INEL.	Sites shipping SNF to INEL would stabilize for purpose of transportation; any further stabilization would be performed at the INEL.	Construction of new facilities for SNF storage.	Same as Alternative 3	Same as Alternative 3

a. ANL-W = Argonne National Laboratories - West; DOE = U.S. Department of Energy; ECF = Expended Core Facility; ICPP = Idaho Chemical Processing Plant; INEL = Idaho National Engineering Laboratory; R&D = research and development; SNF = spent nuclear fuel.

Table 3-2. Potential spent nuclear fuel projects required for each alternative[a].

Facility/Project Name	Alternatives					
	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4.[b] Regionalization	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Test Area North Pool Fuel Transfer	•	•	•	•	•	•
Increased Rack Capacity for CPP-666			•	•		•
Additional Increased Rack Capacity (CPP-666)			•	•		•
Dry Fuels Storage Facility			•	•	•[c]	•[d]
EBR-II Blanket Treatment			•	•		•
Expended Core Facility Dry Cell Construction		•[e]	•	•		•
Fort St. Vrain Spent Fuel Shipment and Storage			•	•		•
Spent Fuel Processing						•
Electrometallurgical Process Demonstration Project at ANL-W FCF[f]			•	•	•	•

a. Appendix C of Volume 2 contains detailed descriptions of the spent nuclear fuel projects identified in this table.
b. Project actions listed are for option 4a only. For purpose of analysis, option 4b(1) is the same as Alternative 5b. Option 4b(2) is the same as Alternative 5a.
c. Includes canning, characterization, and shipping only.
d. Expanded scope.
e. The Expended Core Facility Dry Cell Construction under Alternative 2 would occur for option 2c only.
f. Argonne National Laboratories-West Fuel Cycle Facility.

The alternatives involving the interim storage of naval spent nuclear fuel at sites other than the INEL include a transition period, which would start on June 1, 1995, and continue for approximately 3 years. During this period, approximately 80 shipments of naval spent nuclear fuel would occur to the Expended Core Facility for examination and subsequent shipment to the Idaho Chemical Processing Plant for storage. After this transition period, DOE would phase out the Expended Core Facility such that the worker total at the facility would decline to about 10 by 2001. Appendix D describes this transition period.

3.1.1 Alternative 1: No Action

Table 3-1 lists the basic actions expected under this alternative. This alternative would be restricted to the minimum actions necessary for the continued safe and secure management of spent nuclear fuel. Table 3-3 lists the existing inventory of spent nuclear fuel at the INEL. This alternative is not a status quo condition in terms of spent nuclear fuel receipts (unlike Alternative 3, under which operations would continue in accordance with the 1992/1993 planning basis). Rather, DOE would maintain spent nuclear fuel close to defueling or current storage locations with minimal facility upgrades or replacements.

DOE would continue the operation of the following existing spent nuclear fuel-related facilities: the Fuel Storage Area/Fluorinel Dissolution Process Cell; CPP-603 Underwater Fuel Storage Facility (until 2000); Irradiated Fuel Storage Facility; Underground Storage Facility; Power Burst Facility storage canal; Advanced Test Reactor canal; Advanced Reactivity Measurement Facility; Coupled Fast Reactivity Measurement Facility; Materials Test Reactor canal; Test Area North Pool and Test Pad; Argonne National Laboratory - West Hot Fuel Examination Facility, Radioactive Scrap and Waste Facility, Transient Reactor Test Facility, Zero Power Physics Reactor, and Neutron Radiography Reactor pool. Table 2-2 lists the type(s) of storage and spent nuclear fuels associated with each facility.

3.1.1.1 Transportation. Under this alternative, the INEL would neither receive nor ship spent nuclear fuel except for naval spent fuel during a transition period. DOE would continue to transfer the Advanced Test Reactor canal spent nuclear fuel to the Idaho Chemical Processing Plant. In addition, DOE could transfer other spent nuclear fuel at the INEL site (e.g., Test Reactor Area, Test Area North Pad, Power Burst Facility storage canal, Experimental Breeder Reactor-II, and Naval Nuclear

Table 3-3. Spent nuclear fuel inventory for each alternative by 2035 (metric tons of heavy metal).[a,b,c]

Fuel Type	1. No Action[d]	2. Decentralization	3. 1992/1993 Planning Basis	4a. Regionalization by Fuel Type	4b(1)[e] Regionalization by Geography (INEL)	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Naval-type	10.23	N/C[f]	+55.00	+55.00	+55.00	-10.23	+55.00
Aluminum-clad	2.91	11.02	+12.09	-2.91	+5.85	-2.91	+210.18
Hanford	None	None	None	None	+2,103.17	None	+2,103.17
Graphite	11.60	N/C	+16.00	+16.01	+16.01	-11.60	+16.01
Special case commercial	122.88	+0.03	+26.69	+33.63	+2.30	-122.88	33.63
Stainless-steel-clad	77.43	+1.08	+1.19	+19.08	+12.69	-77.43	+19.08
Zircaloy-clad	49.09	+0.67	+0.670	+28.90	+15.75	-49.09	+28.90
Other	0.01	+0.82	+0.82	+1.69	+0.28	-0.01	+1.69
Net increase (+)/ decrease (-)	-	+13.62	+112.47	+151.41	+2,211.05	-274.14	+2,467.66
TOTAL	274.14	287.76	386.61	425.55	2,485.19	0	2,741.80

a. Source: Wichmann (1995).
b. To convert metric tons to tons, multiply by 1.10. Heavy metals are uranium, plutonium, and thorium.
c. The values may not sum exactly due to rounding.
d. The No-Action Alternative represents the present inventory and projections and serves as the basis for determining the net increase or decrease for each type of spent nuclear fuel for each of the other alternatives.
e. Regionalization 4b(2), Regionalization by Geography (Elsewhere), assumes all spent nuclear fuel inventories at the INEL go to the Nevada Test Site or Hanford Site. Inventories for 4b(2) would equal those listed for Alternative 5a.
f. N/C = No change from the No-Action Alternative.

Propulsion Program prototype reactors at the Naval Reactors Facility) to the Idaho Chemical Processing Plant to the extent of its storage capability.

3.1.1.2 Stabilization. Due to the deteriorated condition of some of the fuel in the CPP-603 Underwater Fuel Storage Facility, additional canning and characterization capabilities would be necessary to stabilize this fuel for safe transport and subsequent storage. DOE has scheduled the installation and operation of new fuel canning and characterization equipment in the Irradiated Fuel Storage Facility, which could provide these capabilities, by late 1995. (The installation of such equipment would be a minor upgrade and would have a smaller extent than similar actions described under Alternatives 3, 4, and 5.) DOE could perform other required stabilization of spent nuclear fuel at the INEL in either the Remote Analytical Laboratory or the Fluorinel Dissolution Process Hot Cell.

3.1.1.3 Storage. DOE has identified the CPP-603 Underwater Fuel Storage Facility as one of five complex-wide spent nuclear fuel storage facilities that exhibit the greatest vulnerabilities according to selected criteria and, therefore, has selected this facility for priority attention (DOE 1993b). As part of the August 9, 1993, agreement between the Secretaries of the Department of Energy and the Department of the Navy and the Governor of Idaho to phase out storage operations in the 45-year old CPP-603 facility, one goal of this and the other alternatives would be to remove spent nuclear fuel from underwater storage in the North and Middle Basins of the CPP-603 facility by the end of 1996 and from the South Basin of this facility by the end of 2000 (DOE 1993a). DOE would relocate this material to the Fuel Storage Area at the Idaho Chemical Processing Plant.

At the Argonne National Laboratory-West, the spent nuclear fuel stored at the Hot Fuel Examination Facility and the Radioactive Scrap and Waste Facility, primarily Experimental Breeder Reactor-II fuel and blanket elements, would remain in dry storage until its potential processing in the Fuel Cycle Facility. At the Experimental Breeder Reactor-II site, DOE would use dry storage with the exception of the Neutron Radiography Reactor pool fuel. The Test Area North Pool Fuel Transfer project would continue, resulting in the relocation of Test Area North spent pool contents into dry cask storage at the Idaho Chemical Processing Plant by 1998. The dry cask storage required for this project is not related to the Dry Fuels Storage Facility.

DOE would start no new projects to increase spent nuclear fuel storage capacity because there is sufficient storage capacity to meet No-Action storage needs. The planning of spent nuclear fuel storage projects such as the Dry Fuels Storage Facility and Additional Increased Rack Capacity for the Fuel Storage Area would stop.

3.1.1.4 Research and Development. There would be only limited spent nuclear fuel research and development. Existing spent nuclear fuel management research and development projects would continue. Existing facilities such as the Process Improvement Facility, the Remote Analytical Laboratory, and the Pilot Plant Facility would support continuing research and development work.

3.1.1.5 Naval-Type Fuel Examination. After a transition period, DOE would cease shipments of naval spent nuclear fuel to the INEL and would phase out the Expended Core Facility. DOE would make onsite shipments of the "library fuel" (a representative sampling of different fuel types maintained for reference purposes) and the spent nuclear fuel that originated at the prototype sites at the Naval Reactors Facility to the Idaho Chemical Processing Plant.

3.1.2 Alternative 2: Decentralization

Under this alternative, DOE could transport fuel for safety or research and development activities. In addition, DOE could undertake actions for safety it deemed desirable, though not essential, and could perform spent nuclear fuel treatment and research and development. As listed in Table 3-3, the anticipated spent nuclear fuel inventory for this alternative would be slightly greater than the inventory for Alternative 1, with the increase consisting primarily of aluminum-clad and stainless-steel-clad spent nuclear fuel from university and foreign research and experimental reactors.

3.1.2.1 Transportation. This alternative assumes that the INEL would accept primarily limited shipments of spent nuclear fuel from offsite sources into the Fuel Storage Area (e.g., DOE or university reactors) after the Record of Decision for this EIS (1995). Onsite transfers could occur from the Fuel Storage Area to the Storage Facility or the Irradiated Fuel Storage Facility. DOE would consolidate the spent nuclear fuel in the Advanced Test Reactor and in the Materials Test Reactor and Power Burst Facility canals at the Idaho Chemical Processing Plant for canning, characterization, and storage.

As in the No-Action Alternative, there would be a transition period during which the Naval Nuclear Propulsion Program would ship naval spent nuclear fuels to the Expended Core Facility for examination and subsequent shipment to the Idaho Chemical Processing Plant for storage. Section 3.1.2.5 describes the transportation of naval spent fuels that would occur after the transition period.

3.1.2.2 Stabilization. DOE would use the canning and characterization equipment identified in Section 3.1.1.2 to stabilize spent nuclear fuel removed from the CPP-603 Underwater Fuel Storage Facility for interim underwater storage.

3.1.2.3 Storage. As in Alternative 1, DOE would transfer the spent nuclear fuel in the CPP-603 Underwater Fuel Storage Facility to the Fuel Storage Area by 2000. DOE would continue to use the Underground Storage Facility and the Irradiated Fuel Storage Facility for existing spent nuclear fuel inventory and transfers of other spent nuclear fuel based on safety analyses. DOE would upgrade or increase fuel storage capacity at the INEL as required.

The Test Area North Pool Fuel Transfer project would result in the relocation of the contents of Test Area North spent nuclear fuel into dry storage at a pad at the Idaho Chemical Processing Plant.

3.1.2.4 Research and Development. The development of technology for the disposition of spent nuclear fuel would continue. Research and development activities would include laboratory and pilot plant testing, continued repository performance assessments and waste acceptance criteria development, and the characterization of spent nuclear fuel. Shipments of samples or selected spent nuclear fuel assemblies to offsite DOE facilities would be necessary.

3.1.2.5 Naval-Type Fuel Examination. DOE would consider three options for naval reactor spent nuclear fuel receipt and shipment. Under options 2a and 2b, DOE would stop shipments of naval spent nuclear fuel to the INEL and would shut down the Expended Core Facility. Option 2c would enable the continued receipt of naval-type fuel for examination at the Expended Core Facility and its return to the originating shipyards for storage in transport casks. Chapter 3 of Appendix D further describes these options. As with Alternative 1, each option would require approximately a 3-year transition period. During this period, DOE would transport spent nuclear fuel in shipping containers to the Expended Core Facility, unload the containers, and use them to support additional refuelings and defueling.

3.1.3 Alternative 3: 1992/1993 Planning Basis

This alternative is consistent with DOE plans at the INEL before the injunction that stopped spent nuclear fuel shipment to the INEL; it assumes a 40-year planning horizon for the continued transportation, receipt, stabilization, and storage of spent nuclear fuel. As with Alternative 1, DOE would continue the maintenance and operation of existing spent nuclear fuel-related facilities; however, some consolidation of INEL facilities could occur. DOE would send newly generated spent nuclear fuel to either the INEL or the Savannah River Site. DOE would assess the construction of new facilities to accommodate current and projected spent nuclear fuel management requirements.

The amount of spent nuclear fuel at the INEL under this alternative would be greater than that for either Alternative 1 or 2 (see Table 3-3) because this alternative assumes that the INEL would

manage, before stabilization and disposal, its present inventory (see Alternative 1) plus additional receipts of DOE spent nuclear fuel, including the following:

- Naval-type spent nuclear fuel
- Approximately half of the aluminum-clad spent nuclear fuel from university and foreign research and experimental reactors
- All Training Reactor Isotopics General Atomics (TRIGA) spent nuclear fuels from the Hanford Site and approximately half of that from foreign, DOE, and university reactors
- Fort St. Vrain spent nuclear fuel from Public Service of Colorado
- Special case commercial pressurized water reactor and boiling water reactor spent nuclear fuel from the DOE facility in West Valley, New York
- Miscellaneous spent nuclear fuel types from such DOE sites as Los Alamos, New Mexico, and Oak Ridge, Tennessee, and from university reactors and other locations

3.1.3.1 Transportation. DOE would consolidate the spent nuclear fuel in the Test Reactor Area (Advanced Test Reactor canal, Materials Test Reactor canal, and Coupled Fast Reactivity Measurements Facility and Advanced Reactivity Measurement Facility canal) and the Power Burst Facility at the Idaho Chemical Processing Plant for canning and dry storage.

The INEL would receive and temporarily store new spent nuclear fuels in the Fuel Storage Area. Transfers could occur from the Fuel Storage Area to the Underground Storage Facility or the Irradiated Fuel Storage Facility or, when available, the dry storage vaults at the proposed Dry Fuels Storage Facility.

At present, DOE is transferring spent nuclear fuel from the Advanced Test Reactor Canal to the Idaho Chemical Processing Plant. DOE would maintain this canal for the storage and management of its recyclable fuel assemblies until the reactor no longer had a mission. The Experimental Breeder Reactor-II spent nuclear fuel in storage would remain at Argonne National Laboratory-West. As with Alternative 2, the Test Area North Pool Fuel Transfer project would result in the relocation of the contents of the Test Area North spent nuclear fuel pool to dry storage at a pad at the Idaho Chemical Processing Plant.

3.1.3.2 Stabilization. DOE would complete a new Canning and Characterization Facility with appropriate inspection, stabilization, and packaging equipment to stabilize new receipts of spent nuclear fuel and to prepare fuel currently in underwater storage for dry storage. This facility would be an integral part of the Dry Fuels Storage Facility that DOE would complete under this alternative. Until the Dry Fuels Storage Facility is in service, DOE would use the canning and characterization equipment described under Alternative 1 to stabilize spent nuclear fuel removed from the CPP-603 Underwater Fuel Storage Facility for interim underwater storage.

3.1.3.3 Storage. As with Alternative 2, DOE would upgrade or increase dry fuel storage capacity at the INEL as required. DOE would complete the Fuel Storage Area increased Rack Capacity project in 1997. Coupled with stringent fuel management and, if necessary, temporary storage of some aluminum fuel in stainless steel racks, this project would allow the Fuel Storage Area to accept all of the project spent nuclear fuel receipts until the Additional Increased Rack Capacity project would be completed in 2001. The Additional Increased Rack Capacity project would allow the Fuel Storage Area to accept the projected spent nuclear fuel receipts until the Dry Fuels Storage Facility project would become available in 2005. The INEL would receive the Fort St. Vrain spent nuclear fuel in the Irradiated Fuel Storage Facility on a space-available basis or in the new vault storage in the Dry Fuels Storage Facility. Modifications to the Irradiated Fuel Storage Facility cask handling equipment would be necessary to accept the new Fort St. Vrain shipping casks.

DOE would continue to use the Underground Storage Facility and the Irradiated Fuel Storage Facility for current inventory and for transfers of other fuel inventories based on safety analyses. Based on these safety analyses, upgrades would be limited to those required for facility safety improvements and for making transfers safely.

3.1.3.4 Research and Development. Spent nuclear fuel research and development would continue as planned, with the construction of a Technology Development Facility. The Electrometallurgical Process Demonstration Project at Argonne National Laboratory - West Fuel Cycle Facility would continue. In addition, Argonne National Laboratory would implement the EBR-II Blanket Processing project under this alternative. The Dry Fuels Storage Facility would develop and demonstrate technology for the dry storage of selected DOE highly enriched uranium fuels.

3.1.3.5 Naval-Type Fuel Examination. The practice of transporting spent nuclear fuel from naval reactors to the Expended Core Facility at the INEL would resume. After an examination, DOE would transfer such fuel to the Idaho Chemical Processing Plant for interim storage pending final disposition. Under this alternative, the Naval Nuclear Propulsion Program would complete the Expended Core Facility Dry Cell Construction project.

3.1.4 Alternative 4: Regionalization

This alternative assumes that DOE would base the spent nuclear fuels shipped between DOE sites and the receipt of fuels from other locations primarily on either geography or fuel type. Alternative 4 offers two options for the redistribution of existing and new spent nuclear fuel:

- Option 4a assumes that DOE would base the spent nuclear fuels shipped between DOE sites and the receipt of fuels from other locations at the INEL, Hanford Site, or the Savannah River Site primarily on fuel type.

- Option 4b assumes that DOE would base the spent nuclear fuels shipped between DOE sites and the receipt of fuels on geography. There would be a single western site at either the Hanford Site, INEL or Nevada Test Site. Option 4b(1) in which the INEL is the western regional site is essentially the same as Alternative 5b. Option 4b(2) in which INEL ships all SNF to another western regional site is the same as Alternative 5a.

3.1.4.1 Transportation. Under option 4a, the INEL would receive all Zircaloy- and stainless-steel-clad spent nuclear fuel. This redistribution would optimize DOE spent nuclear fuel management.

The spent nuclear fuel inventory involved under option 4a would be greater than those for Alternative 1, 2, or 3 because this alternative assumes that the INEL would manage its present inventory plus the following additional spent nuclear fuels (see Table 3-3) prior to stabilization and disposal:

- Naval-type spent nuclear fuel

- All spent nuclear fuel except aluminum-clad fuel and Hanford spent nuclear fuel

- All Training Reactor Isotopics General Atomics spent nuclear fuels from the Hanford Site

- Fort St. Vrain spent nuclear fuel from Public Service of Colorado

- Special case commercial pressurized water reactor and boiling water reactor spent nuclear fuel from the DOE facility in West Valley, New York

Under option 4b(1), DOE would regionalize all western DOE SNF at the INEL. DOE would transport all spent nuclear fuel at other western sites to the INEL. Because the fuel inventory for this alternative would be within 15 percent of that for Alternative 5b, analyses for this option conservatively assume that environmental impacts would be the same as those for as Alternative 5b - Centralization at INEL.

Under option 4b(2), DOE would regionalize all western DOE SNF at either the Nevada Test Site or Hanford Site. DOE would transport spent nuclear fuel at the INEL to the selected western site. As such, this option would be the same as Alternative 5a - Centralization at Other DOE Sites.

3.1.4.2 Stabilization. DOE would stabilize the spent nuclear fuels it would retain at the INEL as planned for Alternative 3, with the construction of such new facilities as a canning and characterization facility and the Dry Fuels Storage Facility. Options 4a and 4b(1) would require such a facility for the receipt and storage of spent nuclear fuel, while option 4b(2) would require stabilization capabilities for shipping spent nuclear fuel. For spent nuclear fuel that the INEL would ship to other regional sites, the receiving site would perform any stabilization beyond that required for transportation.

3.1.4.3 Storage. Under option 4a, DOE would increase dry storage capacity and undertake facility upgrades similar to those described for Alternative 3, with replacements and additions as appropriate. Under option 4b(1), DOE would increase dry storage capacity and undertake facility upgrades similar to those described for Alternative 5b, with replacements and additions as appropriate. Option 4b(2) would not require increased storage capacity and, therefore, there would be no facility upgrades.

3.1.4.4 Research and Development. As with Alternative 3, this alternative would include the continuation of activities related to the treatment of spent nuclear fuel, including research and

development (e.g., Electrometallurgical Process Demonstration Project), and the construction of the Dry Fuels Storage Facility. DOE would initiate pilot programs as needed to support future decisions on spent nuclear fuel management and disposition. DOE would use historic data on spent nuclear fuel to provide the bounding case for a determination of the impacts associated with potential pilot program activities.

3.1.4.5 Naval-Type Fuel Examination. Under options 4a and 4b(1), the transportation of spent nuclear fuel from naval reactors to the Expended Core Facility at the INEL would resume. As with Alternative 1, under option 4b(2) DOE would phase out shipments of naval-type spent nuclear fuel to the INEL and would phase out the Expended Core Facility.

3.1.5 Alternative 5: Centralization

Under this alternative, DOE would send all current and future spent nuclear fuel inventories from both DOE and the Naval Nuclear Propulsion Program to one DOE site for interim storage until final disposition.

The two options under Alternative 5 encompass the extreme ranges of spent nuclear fuel inventories that DOE could store at the INEL (i.e., all or none of the inventory). Under option 5a, DOE would ship the INEL spent nuclear fuel inventory off the site to the Hanford Site, the Savannah River Site, the Nevada Test Site, or the Oak Ridge Reservation. Under option 5b, DOE would ship all existing spent nuclear fuel to the INEL.

This alternative would bound the maximum number of spent nuclear fuel-related actions that DOE could reasonably undertake at any site. DOE would have to build new facilities at the selected site to accommodate the increased inventories. Shipments of spent nuclear fuel to the sites not selected as the centralized destination would continue as an interim action pending the construction of necessary storage and examination facilities at the selected site. DOE would then transfer all spent nuclear fuel to the selected site, and the other sites would close their spent nuclear fuel facilities. Before DOE would ship spent nuclear fuel from the originating site, it would characterize and can all spent nuclear fuel as necessary.

The locations from which spent nuclear fuel would originate, in addition to the Hanford Site and Savannah River Site, would include Argonne National Laboratory - East, Babcock and Wilcox, Brookhaven National Laboratory, General Atomics, Los Alamos National Laboratory, Oak Ridge National Laboratory, Sandia National Laboratories, West Valley, and Fort St. Vrain. This alternative would also include fuel that might be returned to the United States following irradiation or testing.

This alternative would include activities related to the treatment of spent nuclear fuel, including research and development and pilot programs to support future decisions on its disposition. DOE would use historic data on spent nuclear fuel to provide a foundation case for determining the impacts associated with potential pilot program activities.

3.1.5.1 Alternative 5a - Centralization at Other DOE Sites.

3.1.5.1.1 Transportation - This option assumes that the INEL would consolidate and prepare all existing and projected onsite spent nuclear fuel for shipment to another DOE facility: the Hanford Site, the Savannah River Site, the Nevada Test Site, or Oak Ridge.

3.1.5.1.2 Stabilization - The DOE would construct a canning and characterization facility at the Idaho Chemical Processing Plant to accept the different types of INEL spent nuclear fuel in various shipping casks and storage containers, and to stabilize these fuel types before their shipment to the selected DOE facility.

3.1.5.1.3 Storage - As in Alternative 1, DOE would complete the CPP-603 Underwater Fuel Storage Facility pool inventory transfer to existing dry storage facilities by 2000. DOE would not build the Dry Fuels Storage Facility. DOE would then close all spent nuclear fuel-related facilities at the INEL with the exception of those in direct support of operating reactors, such as the Advanced Test Reactor canal or the Argonne National Laboratory-West Hot Fuel Examination Facility and Fuel Cycle Facility. This closure would require the establishment of a major surveillance and maintenance operation until DOE determined the disposition of these facilities. The timeframe for closure would depend on the following factors:

- The time necessary to stabilize the spent nuclear fuel in the CPP-603 Underwater Fuel Storage Facility
- The time necessary for the selected DOE site to prepare facilities qualified to accept the spent nuclear fuel

- The time necessary for the procurement and licensing of shipping containers that would be compatible with the selected receiving DOE site

The spent nuclear fuel inventory that DOE would export off the INEL site for Alternative 5a is the same quantity listed for Alternative 1 (see Table 3-3).

3.1.5.1.4 Research and Development - Under this option there would be a phaseout of all research and development activities, although the Electrometallurgical Process Demonstration Project would continue at the Argonne National Laboratory - West Fuel Cycle Facility (but would stabilize only spent nuclear fuel currently on the site).

3.1.5.1.5 Naval-Type Fuel Examination - As with Alternative 1, DOE would phase out shipments of naval-type spent nuclear fuel to the INEL and would phase out the Expended Core Facility.

3.1.5.2 Alternative 5b - Centralization at the INEL.

3.1.5.2.1 Transportation - This option assumes that the INEL would receive all DOE and naval-type spent nuclear fuel (see Table 3-3).

3.1.5.2.2 Stabilization - The Hanford Site, the Savannah River Site, and other DOE facilities would stabilize as necessary, spent nuclear fuel for safe transportation to the Idaho Chemical Processing Plant. The Hanford Site, the Savannah River Site, and other DOE facilities would procure an undetermined number of additional casks and install cask handling equipment as necessary. DOE would complete an expanded Dry Fuels Storage Facility at the INEL, which would include a new Canning and Characterization Facility similar to that described for Alternative 3. This facility would, if needed, repackage the spent nuclear fuel into compatible canisters for dry storage. Other new facility projects would be the same as those described for Alternative 3. In addition, DOE would begin stabilizing for safe storage all complex-wide spent nuclear fuel, as necessary, in existing facilities at the Idaho Chemical Processing Plant. Upgrades and new facilities would be necessary to support long-term fuel stabilization for ultimate disposition; this would address criticality (unplanned and uncontrolled nuclear fission) concerns about the disposal of spent nuclear fuel in a potential Federal repository.

3.1.5.2.3 Storage - Projects and activities for storage of spent nuclear fuel would be similar to those described for Alternative 3, except that accelerated schedules for the Increased Rack Capacity and Additional Increased Rack Capacity projects would be necessary to accommodate the increased fuel receipts. In addition, the schedule for the Dry Fuel Storage Facility project would have to be accelerated and its scope expanded. For example, the Increased Rack Capacity project may have to be completed in late 1996, the Additional Increased Rack Capacity project may have to be completed in late 1998, and the Expanded Dry Fuels Storage Facility project may have to be completed in 2002. If the Expanded Dry Fuels Storage Facility would become available even earlier, it could eliminate the need for the Additional Increased Rack Capacity project.

3.1.5.2.4 Research and Development - DOE would conduct maximum spent nuclear fuel research and development under this option. As with Alternative 4, the Electrometallurgical Process Demonstration Project would continue at the Argonne National Laboratory - West.

3.1.5.2.5 Naval-Type Fuel Examination - Similar to Alternative 3, the practice of transporting spent nuclear fuel from naval reactors to the Expended Core Facility at the INEL would resume.

3.2 Comparison of Alternatives

Chapter 5 analyzes the environmental consequences of the alternatives. Tables 3-4 through 3-6 summarize and compare the potential impacts associated with each alternative from the information in Chapter 5 for construction, normal operations, and accidents, respectively.

A review of the impacts of the alternatives, as presented in Chapter 5, indicates that impacts would be minimal or negligible in most areas. Further, most areas with measurable impacts would have no appreciable differences among alternatives.

In general, the levels of potential impacts associated with Alternatives 1 through 4 (option 4a) would be similar because the amounts of spent nuclear fuel that DOE would manage at the INEL under these alternatives would be on the same order of magnitude (e.g., 300 to 450 MTHM) and activities would extend throughout the full 40-year management period. The lowest level of overall potential impact at the INEL would occur under Alternative 4b(2) - Regionalization by Geography (Elsewhere) and Alternative 5a - Centralization at Other DOE Sites because DOE would ship INEL spent nuclear fuel off the site well before the management period ended in 2035. Alternative 5b and Alternative 4b(1), under which DOE would ship all or nearly all spent nuclear fuel to the INEL, would result in the greatest potential onsite impacts.

Table 3-4. Comparison of impacts from construction.

Area of Impact	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4a.[a] Regionalization by Fuel Type	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Land Use	No adverse impacts; construction on 0.8 acre[c] in previously disturbed area.	Same as No-Action Alternative	No adverse impacts; construction on 19.3 acres in previously disturbed area.	Same as Alternative 3	Same as No-Action Alternative	No adverse impacts; construction on 30.8 acres in previously disturbed area.
Socioeconomics	No impacts; no net change in employment.	Same as No-Action Alternative	Temporary positive impact on employment with the creation of approximately 375 jobs (peak).	Same as Alternative 3	Temporary positive impact on employment with the creation of approximately 50 jobs (peak).	Same as Alternative 3
Cultural Resources	No adverse impacts; area has been surveyed.	Same as No-Action Alternative	Potential impacts to historic structure; would be mitigated as appropriate.	Same as Alternative 3	Same as No-Action Alternative	Same as Alternative 3
Aesthetic and Scenic Resources	No adverse impacts; previously disturbed areas.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Geologic Resources	Minor localized impacts; consumption of approximately 158,000 cubic meters[b] of aggregate onsite.	Same as No-Action Alternative	Minor localized impacts; consumption of approximately 392,000 cubic meters of aggregate onsite.	Same as Alternative 3	Same as No-Action Alternative	Minor localized impacts; consumption of approximately 1,772,000 cubic meters of aggregate onsite.

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Table 3-4. (continued).

Area of Impact	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4a.[a] Regionalization by Fuel Type	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Air Quality	Nonradiological: Temporary and intermittent increases in fugitive airborne dust and in exhaust emissions from support equipment. Estimated air quality impacts would be well below established Federal and state standards.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
	Radiological: No radiological impacts from construction activities.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Water Quality	No adverse offsite impacts to either surface water or groundwater.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Ecological Resources	Temporary minor impacts; construction confined to previously disturbed areas.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	No impacts	Minimal impacts; construction activities would temporarily disturb wildlife.
Noise	Potential temporary increase in ambient noise levels in construction areas; no change in traffic noise levels.	Same as No-Action Alternative	Potential temporary increase in ambient noise levels in construction areas; small change in traffic noise levels but no change in community reaction to noise.	Same as Alternative 3	Same as Alternative 3	Same as Alternative 3

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Table 3-4. (continued).

Area of Impact	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4a.[a] Regionalization by Fuel Type	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Traffic and Transportation	Negligible impact on traffic.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Occupational and Public Health and Safety	Occupational: Small occupational radiation exposures within INEL guidance.	Same as No-Action Alternative	Same as No-Action Alternative except 23 potential injuries/ illnesses for construction workers.	Same as Alternative 3	Same as No-Action Alternative except 3 potential injuries/ illnesses for construction workers.	Same as No-Action Alternative except 23 potential injuries/illnesses for construction workers.
	Public: No impact.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
INEL Services	No adverse impacts; modest changes that would be easily accommodated.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Materials and Waste Management	9 cubic meters[b] of industrial and commercial solid waste from 1995 through 1996.	Same as No-Action Alternative	Cumulative total of 620 cubic meters of industrial and commercial solid waste, 1,500 cubic meters of low-level waste would be generated from 1995 through 1999.	Same as Alternative 3	Cumulative total of 50 cubic meters of industrial and commercial solid waste.	Cumulative total of 3,800 cubic meters of industrial and commercial solid waste and 1,500 cubic meters of low-level waste would be generated from 1995 through 2008.

a. The data provided are for Alternative 4a. Alternative 4b(1) data are the same as those for Alternative 5b. Alternative 4b(2) data are the same as those for Alternative 5a.
b. To convert cubic meters to cubic feet, multiply by 35.3.
c. To convert acres to square kilometers, multiply by 0.004.

Table 3-5. Comparison of impacts from normal operations.

Area of Impact	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4a.[a] Regionalization by Fuel Type	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Socioeconomics	No impact; no net change in employment.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Air Quality	Nonradiological: Potential contribution to ambient concentrations would be below applicable standards and regulations.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
	Radiological: Worker doses, doses to the maximally exposed individual, and population dose would be negligible.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Water Quality	No adverse offsite impacts to either surface water or groundwater.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Ecological Resources	Negligible impacts, primarily due to continued exclusion of plants and animals from existing facility areas.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Minimal impacts due to generally increased level of operational activity.
Noise	Small change in ambient noise levels in operational areas; no change in traffic noise level.	Same as No-Action Alternative	Small change in ambient noise levels in operational areas; small change in traffic noise levels but no change in community reaction to noise.	Same as Alternative 3	Same as Alternative 3	Same as Alternative 3

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Table 3-5. (continued).

Area of Impact	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4a.[a] Regionalization by Fuel Type	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Traffic and Transportation	Occupational radiation impact: 1.4×10^{-3} LCFs[b] over 40 years.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
	Public radiation impact: 4.4×10^{-5} LCFs over 40 years.	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Occupational and Public Health and Safety	Occupational radiation impact: 4×10^{-4} LCFs over 40 years.	Occupational radiation impact: 4×10^{-4} LCFs over 40 years.	Occupational radiation impact: 8×10^{-2} LCFs over 40 years.	Same as Alternative 3	Occupational radiation impact: 4×10^{-2} LCFs over 40 years.	Occupational radiation impact: 8×10^{-1} LCFs over 40 years.
	Public radiation impact: 2×10^{-3} LCFs over 40 years.	Public radiation impact: 2×10^{-3} LCFs over 40 years.	Public radiation impact: 4×10^{-3} LCFs over 40 years.	Public radiation impact: 4×10^{-3} LCFs over 40 years.	Public radiation impact: 2×10^{-3} LCFs over 40 years	Public radiation impact: 8×10^{-3} LCFs over 40 years.
INEL Services	Less than 0.1 percent increase in electricity demand and approximately 0.25 percent increase in fuel oil consumption. No increases in water consumption or wastewater generation.	Same as No-Action Alternative	Approximately 1 percent increase in electricity demand and 3 percent increase in fuel oil consumption, which are well within current system capacities or usage limits. No increase in water consumption or wastewater generation.	Same as Alternative 3	Approximately 1.0 percent increase in electricity demand and 2.7 percent increase in fuel oil consumption, which are well within current system capacities or usage limits. No increase in water consumption or wastewater generation.	Approximately 5.3 percent increase in electricity demand, 0.7 percent increase in water consumption, negligible increase in wastewater generation, and 9.7 percent increase in fuel oil consumption, which are well within current system capacities or usage limits.

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Table 3-5. (continued).

Area of Impact	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4a.[a] Regionalization by Fuel Type	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Materials and Waste Management	No increase in waste generation.	Same as No-Action Alternative	Waste generation would increase annually as follows: Industrial and commercial solid waste - 600 cubic meters[b] from 1996 through 2035. Low-level waste - 200 cubic meters from 1996 through 2035. High-level waste - 3 cubic meters from 1996 through 2024. Mixed low-level waste - <1 cubic meters from 1996 through 2024. Transuranic waste - 32 cubic meters from 1996 through 2024.	Same as Alternative 3	Waste generation would increase annually as follows: Industrial and commercial solid waste - 210 cubic meters from 1996 through 2024. Low-level waste - 83 cubic meters from 1996 through 2024. High-level waste, mixed low-level waste, and transuranic waste - same as Alternative 3.	Waste generation would increase annually as follows: Industrial and commercial solid waste - 2,600 cubic meters from 1996 through 2035. Low-level waste - 410 cubic meters from 1996 through 2035. High-level waste - 120 cubic meters from 1996 through 2034. Mixed low-level waste and transuranic waste - same as Alternative 3.

a. The data provided are for Alternative 4a. Alternative 4b(1) data are the same as those for Alternative 5b. Alternative 4b(2) data are the same as those for Alternative 5a.
b. To convert cubic meters to cubic feet, multiply by 35.3.
c. LCFs = Latent Cancer Fatalities

Table 3-6. Comparison of impacts from accidents.

Area of Impact	1. No Action	2. Decentralization	3. 1992/1993 Planning Basis	4a.[a] Regionalization by Fuel Type	5a. Centralization at Other DOE Sites	5b. Centralization at the INEL
Facility Accidents (Maximum reasonably foreseeable accident[c])	Individual Worker Radiological Risk[b]: 1.8×10^{-10} LCFs[d]/year	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	3.6×10^{-6} LCFs/year
	Public (Population) Radiological Risk[a]: 7.0×10^{-5} LCFs/year	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
Transportation Accident (Maximum reasonably foreseeable accident)	Public (Population) Radiological Risk: 1.1×10^{-5} LCFs/year[d]	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
	Occupational Traffic Fatalities over 40 years: 7.1×10^{-4}	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative
	Public Traffic Fatalities over 40 years: 2.5×10^{-3}	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative	Same as No-Action Alternative

a. The data provided are for Alternative 4a. Alternative 4b(1) data are the same as those for Alternative 5b. Alternative 4b(2) data are the same as those for Alternative 5a.
b. Risk is the product of accident probability and consequences (latent cancers fatalities).
c. This accident represents the maximum reasonably forseeable accident analyzed with the largest consequences to the receptor.
d. LCFs = Latent Cancer Fatalities.
e. Includes noninvolved INEL worker population downwind of the accident; INEL workers are a small portion of the affected population.

4. AFFECTED ENVIRONMENT

4.1 Overview

Chapter 4 describes the existing environment at the Idaho National Engineering Laboratory (INEL) site and the surrounding region. It emphasizes areas that the proposed spent nuclear fuel management alternatives could affect. The information in this chapter provides the existing environmental conditions against which the Department of Energy (DOE) can measure the potential environmental effects of the alternatives. It supports the assessment of the potential environmental consequences that Chapter 5 discusses. DOE used the discussion of the Affected Environment in Volume 2 of this EIS as input for this chapter.

4.2 Land Use

The INEL site encompasses 570,914 acres (2,310.4 square kilometers) in Butte, Bingham, Jefferson, Bonneville, and Clark Counties, Idaho. This section describes existing land uses at the INEL and in the surrounding region, and land use plans and policies applicable to the surrounding area.

4.2.1 Existing and Planned Land Uses at the INEL

Categories of land use at the INEL include facility operations, grazing, general open space, and infrastructure such as roads. Facility operations include industrial and support operations associated with energy research and waste management activities (DOE also conducts such activities at its Idaho Falls facilities). In addition, DOE uses INEL land for recreation and environmental research associated with the designation of the INEL as a National Environmental Research Park.

Much of the INEL is open space that DOE has not designated for specific uses. Some of this open space serves as a buffer zone between INEL facilities and other land uses. Facilities and operations use about 2 percent of the total INEL site area (11,400 acres or 46 square kilometers). Public access to most facility areas is restricted. Approximately 6 percent of the INEL, or 32,985 acres (133.5 square kilometers), is devoted to public roads and utility rights-of-way that cross the site. Recreational uses include public tours of general facility areas and the Experimental Breeder Reactor-I (a National Historic Landmark), and controlled hunting, which is generally restricted to 0.5 mile (0.8 kilometer) inside the INEL boundary.

Cattle and sheep grazing occupies between 300,000 and 350,000 acres (1,200 and 1,400 square kilometers). The U.S. Sheep Experiment Station uses a 900-acre (3.6-square-kilometer) portion of this land, at the junction of Idaho State Highways 28 and 33, for a winter feed lot for approximately 6,500 sheep. Grazing is not allowed within 2 miles (3.2 kilometers) of any nuclear facility and, to avoid the possibility of milk contamination by long-lived radionuclides, dairy cattle are not permitted on the site. The Department of the Interior's Bureau of Land Management grants and administers rights-of-way and grazing permits. Figure 4.2-1 shows selected land uses at the INEL and in the surrounding region.

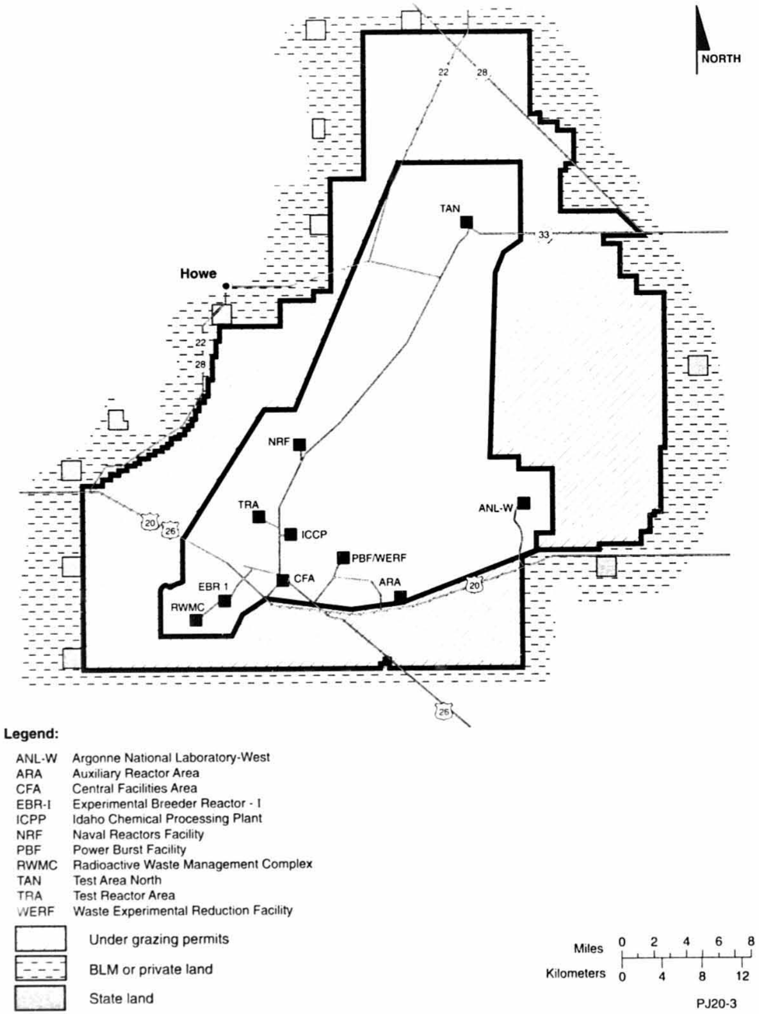


Figure 4.2-1. Selected land uses at the INEL and in the surrounding region.

The INEL site is within the Medicine Lodge Resource Area (approximately 140,415 acres or 568.3 square kilometers in the eastern and southern portions of the INEL site) and the Big Butte Resource Area (430,499 acres or 1,742 square kilometers in the central and western portions); the Bureau of Land Management administers both of these areas. Under Resource Management Plans, the Bureau manages portions of these Resource Areas for grazing and wildlife habitat. No mineral exploration or development is allowed on INEL land.

DOE land use plans and policies applicable to the INEL include the INEL *Institutional Plan - Fiscal Year 1994 - 1999* (DOE-ID 1993c) and the *INEL Technical Site Information Report* (DOE-ID 1993a). The *Institutional Plan* provides a general overview of INEL facilities, outlines strategic program directions and major construction projects, and identifies specific technical programs and capital equipment needs. The *Technical Site Information Report* presents a 20-year master plan for development activities at the site. Under the scope of these planning documents, energy research and waste management activities would continue in existing facility areas and, in some instances, expand into currently undeveloped site areas. These documents also describe environmental restoration, waste management, and spent nuclear fuel activities. Projected land use scenarios for the next 25 to 50 years include the outgrowth of current functional areas and the possible development of waterfowl production ponds in existing grazing areas.

No onsite land use restrictions due to Native American treaty rights would exist for any of the alternatives described in this EIS. The INEL does not lie within any of the land boundaries established by the Fort Bridger Treaty, and the entire INEL site is land occupied by the U.S. Department of Energy. Therefore, the provisions in the Fort Bridger Treaty that allows the Shoshone-Bannock Indians to hunt on unoccupied lands of the United States do not apply to the INEL site.

4.2.2 Existing and Planned Land Use in Surrounding Areas

The Federal government, the State of Idaho, and private parties own the lands surrounding the INEL site. Land uses on Federally owned land consist of grazing, wildlife management, range land, mineral and energy production, and recreational uses. State-owned lands are used for grazing, wildlife management, and recreational purposes. Privately owned lands are used primarily for grazing, crop production, and range land.

Small communities and towns near the INEL boundaries include Mud Lake to the east; Arco, Butte City, and Howe to the west; and Atomic City to the south. The larger communities of Idaho Falls, Rexburg, Blackfoot, and Pocatello and Chubbock are to the east and southeast of the INEL site. The Fort Hall Indian Reservation is to the southeast of the INEL. Recreation and tourist attractions in the region around the INEL include the Craters of the Moon National Monument, Hell's Half Acre Wilderness Study Area, Black Canyon Wilderness Study Area, Camas National Wildlife Refuge, Market Lake State Wildlife Management Area, North Lake State Wildlife Management Area, Yellowstone National Park, Grand Teton National Park, Jackson Hole Recreation Complex, Targhee and Challis National Forests, and the Snake River.

Lands surrounding the INEL site are subject to Federal and state planning laws and regulations. Federal rules and regulations that require public involvement in their implementation govern planning for and use of Federal lands and their resources. Land use planning in the State of Idaho is derived from the Local Planning Act of 1975 (State of Idaho Code 1975). Because the State currently has no land use planning agency, the Idaho legislature requires each county to adopt its own land use planning and zoning guidelines. County plans that are applicable to lands bordering the INEL site include the Clark County Planning and Zoning Ordinance and Interim Land Use Plan (Clark County 1994); Bonneville County Comprehensive Plan (Bonneville County 1976); Bingham County Zoning Ordinance and Planning Handbook (Bingham County 1986); Jefferson County Comprehensive Plan (Jefferson County 1988); and Butte County Comprehensive Plan (Butte County 1992). Land use planning for INEL facilities within the Idaho Falls city limits is subject to Idaho Falls planning and zoning restrictions (City of Idaho Falls 1989, 1992).

All county plans and policies accept development adjacent to previously developed areas to minimize the need to extend infrastructure improvements and to avoid urban sprawl. Because the INEL is remote from most developed areas, INEL lands and adjacent areas are not likely to experience residential and commercial development; no new development is planned near the INEL site. However, DOE expects recreational and agricultural uses to increase in the surrounding area in response to greater demand for recreational areas and the conversion of range land to crop land.

4.3 Socioeconomics

This section presents a brief overview of current socioeconomic conditions within a region of influence where approximately 97 percent of the INEL workforce lived in 1991 (DOE-ID 1991). The INEL region of influence is a seven-county area comprised of Bingham, Bonneville, Butte, Clark, Jefferson, Bannock, and Madison Counties. The region of influence also includes the Fort Hall Indian Reservation and Trust Lands (home of the Shoshone-Bannock Tribes) in Bannock, Bingham, Caribou, and Power Counties.

4.3.1 Employment

Historically, the regional economy has relied predominantly on natural resource use and extraction. Today, farming, ranching, and mining remain important components of the regional economy. Idaho Falls is the retail and service center for the region of influence, and Pocatello has evolved into an important processing and distribution center and site of higher education institutions.

4.3.1.1 Region. The labor force in the region of influence increased from 92,159 in 1980 to 104,654 in 1991, an average annual growth rate of approximately 1.2 percent. In 1991 the region of influence accounted for approximately 18 percent of the total state labor force of 504,000 (ISDE 1992). As listed in Table 4.3-1, the projected labor force in the region of influence will reach 108,667 by 1995.

Unemployment rates varied considerably among the counties of the region of influence in 1991, ranging from 2.6 percent in Clark County to 6.3 percent in Bannock and Bingham Counties. Since 1980 the average annual unemployment rate for the region has ranged from 5.3 percent in 1989 to 8.3 percent in 1983. In 1991 the average annual unemployment rate for the region of influence was 5.5 percent compared to the statewide average of 6.2 percent (ISDE 1992).

Employment in the region of influence increased from 86,261 in 1980 to 98,898 in 1991, an average annual growth rate of approximately 1.3 percent. As listed in Table 4.3-1, employment is projected to increase to 101,450 by 1995.

Table 4.3-1. Projected labor force, employment, and population for the INEL region of influence, 1995-2004.

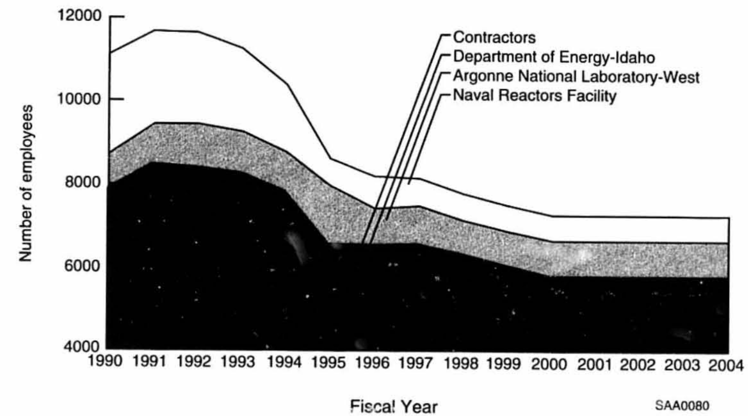
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Labor Force	108.667	109.607	110.547	111.487	112.427	113.367	114.308	115.248	116.188	117.128
Employment	101.450	102.328	103.205	104.083	104.960	105.838	106.716	107.593	108.471	109.348
Population	247.990	251.518	255.096	258.726	262.406	266.140	268.667	271.219	273.795	276.395

Source: ISDE (1992); SAIC (1994); ISDE (1991); ISDE (1986).

4.3.1.2 Idaho National Engineering Laboratory. INEL plays a substantial role in the regional economy. During Fiscal Year 1990, INEL directly employed approximately 11,100 personnel, accounting for almost 12 percent of total regional employment. The estimated population directly supported by INEL employment was approximately 38,000 persons, or 17 percent of the total regional population. The major employers at INEL are DOE-ID, DOE-ID contractors, Argonne National Laboratory-West, and the Naval Reactors Facility (see Figure 4.3-1). In 1992, the total direct INEL employment was approximately 11,600 jobs (DOE-ID 1994). Projections as of January 1995 indicate that the total number of jobs at INEL will decrease to approximately 8,620 in Fiscal Year 1995 and to approximately 7,250 in Fiscal Year 2004 (Tellez 1995). Projected decreases in INEL employment are primarily related to contractor consolidation, which accounts for 64 percent of the projected losses between Fiscal Year 1994 and Fiscal Year 2004, and to reduced activities at the Naval Reactors Facility, which accounts for 33 percent of the projected job losses. Contract changes at DOE-ID resulted in the consolidation of several contracts under one contract. The consolidation eliminated redundant administrative activities previously performed by each individual contractor and offered early retirement or other options to impacted INEL contractor employees.

4.3.2 Population and Housing

4.3.2.1 Population. From 1960 to 1990, population growth in the region of influence mirrored statewide growth. During this period, the region's population increased at an average annual rate of approximately 1.3 percent, while the growth rate for the State was 1.4 percent. Between 1980 and 1990, population growth in the region of influence approximately equaled that of the State with an average growth rate of 0.6 percent per year. The region of influence had a 1990 population of 219,713, which comprised 22 percent of the total State population of 1,006,749. Based on population and employment trends, the population in the region of influence will reach approximately 248,000 persons by 1995 (Table 4.3-1).



Source: Tellez (1995); DOE-ID (1994)

PJ20-3

Figure 4.3-1. Historic and projected baseline employment at the Idaho National Engineering Laboratory, 1990-2004.

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In 1990, the most populous counties were Bannock and Bonneville, which together contained over 60 percent of the seven-county total (Figure 4.3-2). Butte and Clark were the least populous of the counties in the region of influence. The largest cities in the region of influence are Pocatello and Idaho Falls, with 1990 populations of approximately 46,000 and 44,000, respectively. In 1990, the Fort Hall Indian Reservation and Trust Lands contained 5,113 residents, most of whom (52 percent) resided in Bingham County.

4.3.2.2 Housing. Bonneville and Bannock Counties (which respectively include the cities of Idaho Falls and Pocatello) provided 67 percent of the 73,230 year-round housing units in the region of influence in 1990 (see Table 4.3-2). Of this number, approximately 70 percent were single-family units, 17 percent were multifamily units, and 13 percent were mobile homes. Most of the multifamily units (75 percent) were in Bonneville and Bannock Counties. About 29 percent of the occupied housing units in the region were rental units and 71 percent were homeowner units (USBC 1992).

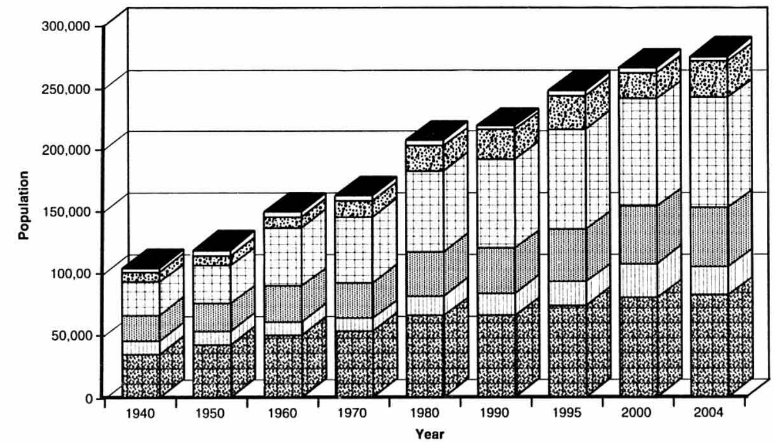
The median value of owner-occupied housing units ranged from $37,300 in Clark County to $68,700 in Madison County, and median monthly rents ranged from $243 in Butte County to $366 in Bonneville County. In 1990, there were 1,510 occupied housing units on the Fort Hall Indian Reservation and Trust Lands (USBC 1992) and a vacancy rate of 14 percent.

4.3.3 Community Services

This assessment considers the following selected community services in the region of influence: public schools, law enforcement, fire protection, hospital services, and solid waste disposal. Table 4.3-3 summarizes pertinent characteristics of these services for the region of influence.

Seventeen public school districts and three nonpublic schools provide educational services for about 58,000 children in the region of influence. Of these students, about 6,500 were dependents of INEL-related employees. During the 1990-1991 academic year, most public school districts spent an average of $3,000 to $4,000 per student annually. Higher education in the region is provided by the University of Idaho, Idaho State University, Brigham Young University, Ricks College, and the Eastern Idaho Technical College.

Seven county sheriff's offices, 12 city police departments, and the Idaho State Police provide law enforcement services in the region. There was a total of 479 sworn officers and 100 other law



Note: 1995 to 2004 represent population projection

Legend:
- Clark
- Butte
- Madison
- Bonneville
- Bingham
- Jefferson
- Bannock

Source: USBC (1982); USBC (1992). PJ20-3

Figure 4.3-2. Historic and projected total population for the counties of the region of influence, 1940 through 2004.

Table 4.3-2. Number of housing units, vacancy rates, median house value, and median monthly rent by county and region of influence.[a]

	Homeowner housing units			Rental units		
County	Number of units	Vacancy rates	Median value ($)	Number of units	Vacancy rates	Median monthly rent ($)
Bannock	16,447	2.4	53,300	7,467	10.3	294
Bingham	9,010	2.0	50,700	2,955	9.2	284
Bonneville	17,707	1.9	63,700	7,375	6.2	366
Butte	780	4.6	41,400	302	16.2	243
Clark	177	1.7	37,300	114	9.6	281
Jefferson	4,000	2.0	54,300	992	4.1	314
Madison	3,522	1.3	68,700	2,392	2.8	299
Region of influence	51,674	2.1	-	21,556	4.6	-

a. Source: USBC (1992).

enforcement personnel in 1991, more than 59 percent of whom served Bannock and Bonneville Counties.

Eighteen fire districts in the region of influence operate 30 fire stations staffed by 180 paid and approximately 300 volunteer firefighters. Bingham, Bonneville, Butte, Clark, and Jefferson Counties, which surround the INEL, have developed emergency plans to be implemented in the event of a radiological or hazardous materials emergency. Each emergency plan identifies facilities with extremely hazardous substances and defines transportation routes for these substances. The emergency plans also include procedures for notification and response, listings of emergency equipment and facilities, evacuation routes, and training programs.

Eight hospitals serve the region of influence with more than 900 licensed beds and a capacity of nearly 128,000 patient-days per year. Occupancy rates range from 22.0 to 61.7 percent in the region (IDHW 1990). County governments and the Blackfoot, Dubois, Idaho Falls, and Pocatello fire departments provide regional ambulance services. A private ambulance company serves residents in Butte County. Four quick-response units, two medical helicopters, and two clinics specializing in emergency medical services also serve the region of influence (Hardinger 1990; U.S. West Directories 1992).

Table 4.3-3. Summary of public services available in the region of influence.[a]

Public Service	County						
	Bannock	Bingham	Bonneville	Butte	Clark	Jefferson	Madison
Schools							
Number of public school districts	2	5	3	1	1	3	2
Total enrollment	15,455	11,311	17,896	765	166	5,339	5,967
Number of INEL-related students (excluding military)	485	1,532	4,040	301	5	134	47
Health Care Delivery							
Number of hospitals	3	2	1	1	0	0	1
Number of licensed beds	309	238	311	4	-	-	52
Law Enforcement							
Number of sworn law enforcement officers	151	65	143	4	2	18	43
Total personnel per 1000 population	2.5	2.0	2.2	1.3	6.3	1.6	1.9
Fire Protection							
Number of fire stations	9	7	6	2	1	4	1
Number of firefighters	166	96	121	15	7	63	24
Number of firefighting vehicles	37	25	24	3	1	11	6
Municipal Solid Waste Disposal							
Number of landfills meeting EPA[b] regulations	1[c]	3[d]	1[e]	2	0[f]	1	0[f]
Expected lifespan in years	30	3-6	50	30	-	2	-

a. Source: IDE (1991); IDHW (1990); IDLE (1991); Kouris (1992a); and Kouris (1992b).
b. EPA = U.S. Environmental Protection Agency.
c. Fort Hall Mine Landfill is being redesigned to meet EPA standards.
d. Aberdeen Landfill may close due to noncompliance with EPA standards.
e. A new landfill is replacing Bonneville County Landfill.
f. Madison and Clark Counties are evaluating a regional landfill for use after 1993.

Municipal solid waste generated in the region of influence is transported to county landfills. In 1992, twelve landfills served the region of influence. Four landfills (one each in Bannock, Clark, Jefferson, and Madison Counties) will close without replacement before reaching their planned capacity due to noncompliance with new Environmental Protection Agency standards (CFR 1991a).

4.3.4 Public Finance

In Fiscal Year 1991, total county revenues for the region of influence amounted to approximately $90 million (see Table 4.3-4). County governments receive most of their revenues from taxes and intergovernmental transfers. In 1991 the total assessed value of taxable property in the region of influence was about $4.5 billion. In addition to property tax revenues, local governments (cities and counties) also receive revenue from sales tax disbursements and revenue-sharing programs. These two sources provide approximately 60 to 85 percent of the total revenues received by each county.

Table 4.3-4. Total revenues and expenditures by county, Fiscal Year 1991.[a]

County	Total revenues ($)	Total expenditures ($)
Bannock	16,232,274	14,216,708
Bingham	11,434,200	10,708,011
Bonneville[b]	50,186,650	51,850,100
Butte	1,417,684	1,397,012
Clark	1,236,849	1,086,379
Jefferson	4,408,236	4,566,074
Madison	5,249,432	5,662,080
Seven-county region	90,165,325	89,486,364

a. Sources: Ghan (1992); Bingham County (circa 1992); McFadden (circa 1992); Swager & Swager (1992a); Swager & Swager (1992b); Draney, Searle, and Associates (1992); Schwendiman & Sutton (1992).
b. Bonneville County's financial statements and total revenue data include special accounts for schools, cities, cemeteries, fire districts, ambulance districts, and other special accounts not found in other county budgets. The majority of intergovernmental revenue is used to fund these accounts.

Although DOE as a Federal agency is exempt from paying state or local taxes, INEL employees and contractors are not. In 1992, INEL employees paid an estimated $60 million in Federal withholding tax and $24 million in state withholding tax.

In 1991 the major categories of county government expenditures were general government services, 27 percent; road maintenance, 18 percent; public safety, 16 percent; health and welfare programs, 16 percent; sanitation and public works, 9 percent; debt service, 3 percent; trust remittances, 2 percent; and other expenditures, 9 percent.

4.4 Cultural Resources

This section discusses cultural resources at the INEL, including prehistoric and historic archeological sites and historic sites and structures, and traditional resources that are of cultural or religious importance to local Native Americans. It also discusses paleontological localities on the INEL site.

4.4.1 Archeological Sites and Historic Structures

As summarized in the INEL Draft Management Plan for Cultural Resources (Miller 1992), the INEL contains a rich and varied inventory of cultural resources. This includes fossil localities that provide an important paleontological context for the region and the many prehistoric archeological sites that are preserved within it. These latter sites, including campsites, lithic workshops, cairns, and hunting blinds, among others, are also an important part of the INEL inventory because they provide information about the activities of aboriginal hunting and gathering groups who inhabited the area for approximately 12,000 years. In addition, archeological sites, pictographs, caves, and many other features of the INEL landscape are also important to contemporary Native American groups for historic, religious, and traditional reasons. Historic sites, including the abandoned town of Powell/Pioneer, a northern spur of the Oregon Trail known as Goodale's Cutoff, many small homesteads, irrigation canals, sheep and cattle camps, and stage and wagon trails, document the use of the area during the late 1800s and early 1900s. Finally, the many scientific and technical facilities inside the INEL boundaries have preserved important information on the historic development of nuclear science in America.

To date, more than 100 cultural resource surveys have been conducted over approximately 4 percent of the area on the INEL site. These surveys, most of which have occurred near major facility areas, have identified 1,506 archeological resources, including 688 prehistoric sites, 38 historic sites, 753 prehistoric isolates, and 27 historic isolates (Miller 1992; Gilbert and Ringe 1993). These numbers do not include architectural properties associated with the creation and operation of the INEL. Until formal significance evaluations (archeological testing and historic records searches) have been completed, all cultural sites in this inventory are considered to be potentially eligible for nomination to the National Register of Historic Places. However, all the isolates have been categorized as unlikely to meet eligibility requirements (Yohe 1993).

Due to the relatively high density of prehistoric sites on the INEL and the need to consider these resources during Federal undertakings, DOE has sponsored a preliminary study, which resulted in the development of a predictive model, to identify areas where densities of sites are highest and where the potential impacts to significant archeological resources, as well as costs of compliance, would increase correspondingly (Ringe 1993). This information provides guidance for INEL project managers in the selection of appropriate areas for new construction. However, it does not take the place of inventories that are required by the National Historic Preservation Act before ground-disturbing projects can start (NHPA 1966 as amended).

The predictive model, constructed using a multivariate statistical technique on environmental variables associated with areas with and without sites, indicates that prehistoric cultural resources appear to be concentrated in association with certain definable physical features of the land. In this context, very high densities of resources are likely to occur along the Big Lost River and Birch Creek, atop buttes, and within craters and caves. The Lemhi Mountains, the Lake Terreton basin, and a 1.75-mile- (2,800-meter-) wide zone along the edge of local lava fields probably contain a fairly high density of sites. Within the extensive flows of basaltic lava and along the low foothills of the Lemhi Mountains, site density is classified as moderate, and the lowest density of prehistoric resources probably occurs in the floodplain of the Big Lost River and the alluvial fans emerging from the Birch Creek Valley, in the sinks, and in the recent Cerro Grande lava flow. However, a classification of low or medium density does not eliminate the possibility that significant resources exist in those areas. Although the predictive model has not been tested, it is useful as a planning guide for defining areas most likely to contain archeological resources based on past surveys.

Although there has been no systematic inventory of historically significant facilities associated with the creation and operation of the INEL, a preliminary study indicated that all INEL facilities will require evaluation (Braun et al. 1993). The Experimental Breeder Reactor-I is a National Historic Landmark listed in the National Register of Historic Places. To date, however, few of the other properties have been formally evaluated for eligibility to the National Register. Memoranda of Agreement between DOE, the Idaho State Historic Preservation Office, and the National Advisory Council on Historic Preservation establish that certain structures at Test Area North (DOE 1993b) and Auxiliary Reactor Area (DOE 1993a) are eligible for nomination, and outline specific techniques for preserving the historic value of the areas in conformance with the requirements of the Historic American Building Survey and the Historic American Engineering Record. Other facilities on the INEL site are likely to require similar efforts if DOE schedules them for major modification, demolition, or abandonment.

4.4.2 Native American Cultural Resources

Because Native American people believe the land is sacred, the entire INEL reserve is culturally important to them. Cultural resources, to the Shoshone-Bannock peoples, include all forms of traditional lifeways and usage of all natural resources. This includes not only prehistoric archeological sites, which are important in a religious or cultural heritage context, but also features of the natural landscape, air, plant, water, or animal resources that might have special significance. These resources may be affected by changes in the visual environment (construction, ground disturbance, or introduction of a foreign element into the setting), dust particles, or by contamination. Geographically, the INEL is included within a large territory once inhabited by and still of importance to the Shoshone-Bannock Tribes. Plant resources used by the Shoshone-Bannock Tribes that are located on or near the INEL site are listed in Table 4.4-1. Areas significant to the tribes would include the buttes, wetlands, sinks, grasslands, juniper woodlands, Birch Creek, and the Big Lost River.

Five Federal laws prompt consultation between Federal agencies and Indian Tribes: the National Environmental Policy Act (NEPA 1969), the National Historic Preservation Act (NHPA 1966 as amended), the American Indian Religious Freedom Act (AIRFA 1978), the Archeological Resources Protection Act (ARPA 1979), and the Native American Graves Protection and Repatriation Act (NAGPRA 1990). In accordance with these directives and in consideration of its Native American Policy (DOE 1990a and DOE 1992a), DOE is developing procedures at the INEL for consultation and coordination with the Shoshone-Bannock Tribes of the Fort Hall Reservation. DOE has committed to additional interaction and exchange of information with the Shoshone-Bannock Tribes, and has outlined this relationship in a formal Working Agreement with these tribes (DOE 1992c). In addition, the Cultural Resources Management Plan for the INEL (Miller 1992) and the curation agreement for permanent storage of archaeological materials will be completed by June 1996. The Cultural Resources Management Plan will define procedures for involving the tribes during the planning stages of project development and the curation agreement will provide for the repatriation of burial goods in accordance with NAGPRA.

4.4.3 Paleontological Resources

There are 31 known fossil localities at the INEL site. Available information suggests that the region has relatively abundant and varied paleontological resources. Preliminary analyses suggest that

Table 4.4-1. Plants used by the Shoshone-Bannock tribes that are located on or near the INEL.

Plant Family	Type of Use	Location	Abundance
Desert Parsley	medicine, food	scattered over site	common
Milkweed	food, tools	roadsides	scattered, uncommon
Sagebrush	medicine, tools	throughout the site	common, abundant
Balsamroot	food, medicine	around buttes	common but scattered
Thistle	food	scattered throughout site	common but scattered
Gumweed	medicine	disturbed areas	common
Sunflower	medicine, food	roadside	common
Dandelion	food, medicine	throughout site	common
Beggar's Ticks	food	disturbed areas throughout site	common, abundant
Tansymustard	food, medicine	disturbed areas	common
Cactus	food	throughout the site	common, abundant
Honeysuckle	food, tools	Big Southern Butte	common on butte
Goosefoot	food	throughout site	common, abundant
Russian Thistle	food	disturbed areas throughout site	common, abundant
Dogwood	food, medicine, tools	Webb Springs, Birch Creek	common where found
Juniper	medicine, food, tools	throughout site	common to abundant
Gooseberry	food	scattered throughout site	common
Mentha arvensis	medicine	Big Lost River	uncommon
Wild onion	food, medicine, dye	throughout site	common
Caloehortus spp.	food	buttes	common
Fireweed	food	throughout site	common
Pine	food, tools, medicine	Big Southern Butte	common on butte
Douglas Fir	medicine	Big Southern Butte	common on butte
Plantain	medicine, food	throughout site	uncommon
Wildrye	food, tools	throughout site	common, abundant
Indian Ricegrass	food	throughout site	common, abundant
Bluegrass	food, medicine	throughout site	common, abundant
Serviceberry	food, tools, medicine	buttes	common where found
Chokeberry	food, medicine, tools, fuel	buttes	common where found
Wood's Rose	food, smoking, medicine, ritual	Big Lost River, Big Southern Butte	common, abundant
Red Raspberry	food, medicine	Big Southern Butte	uncommon
Willow	medicine	throughout site in moist areas	common
Coyote Tobacco	smoking, medicine	Big Lost River, Webb Springs	uncommon
Cattail	food, tools	sinks, outflow from facilities	uncommon

Source: Andersen et al. (1995).

these materials are most likely to occur in association with archeological sites; in areas of basalt flows; in deposits of the Big Lost River, Little Lost River, and Birch Creek; in deposits of Lake Terreton and playas; in some wind and sand deposits; and in sedimentary interbeds or lava tubes within local lava flows (Miller 1992).

4.5 Aesthetic and Scenic Resources

4.5.1 Visual Character of the INEL Site

The Bitterroot, Lemhi, and Lost River mountain ranges border the INEL site on the north and west. Persons can see volcanic buttes near the southern boundary of the INEL from most locations on the site and from the Fort Hall Reservation. Most of the INEL site consists of open undeveloped land, covered predominantly by large sagebrush and grasslands (see Section 4.9). Pasture and irrigated farmland border much of the INEL site (see Section 4.2).

Although the INEL has a master plan, it has not established specific visual resource standards. The nine facility areas on the INEL site are generally of low density, look like commercial or industrial complexes, and are spread across the site. Structures in the facility areas range in height from 10 feet to approximately 100 feet (3 to 30 meters). About 90 miles (145 kilometers) of paved public highway run through the INEL site (see Section 4.11). Although many INEL facilities are visible from these highways, most facilities are located more than 0.5 mile (0.8 kilometer) from public roads.

4.5.2 Scenic Areas

The Craters of the Moon National Monument is about 15 miles (24 kilometers) southwest of the INEL site's western boundary. The Monument is located in a designated Wilderness Area, which must maintain Class I (very high) air quality standards or minimal degradation, as defined by the Clean Air Act (CAA 1990; CFR 1990; CFR 1991b). Under Section 169a of the Clean Air Act, air quality includes visibility and scenic view considerations.

Lands adjacent to the INEL under Bureau of Land Management jurisdiction are Visual Resource Management Class II areas (BLM 1984; BLM 1986), which urge preservation and retention of the existing character of the landscape. Lands inside the INEL boundaries are Class III and IV areas, the most lenient classes in terms of modification. The Bureau of Land Management is considering the Black Canyon Wilderness Study Area, which is adjacent to the INEL, for a Wilderness Area designation (BLM 1986); if approved, this would result in an upgrade from Visual Resource Management Class II to a Class I.

Features of the natural landscape have special significance to the Shoshone-Bannock tribes. The visual environment of the INEL site is within the visual range of Fort Hall Reservation.

4.6 Geology

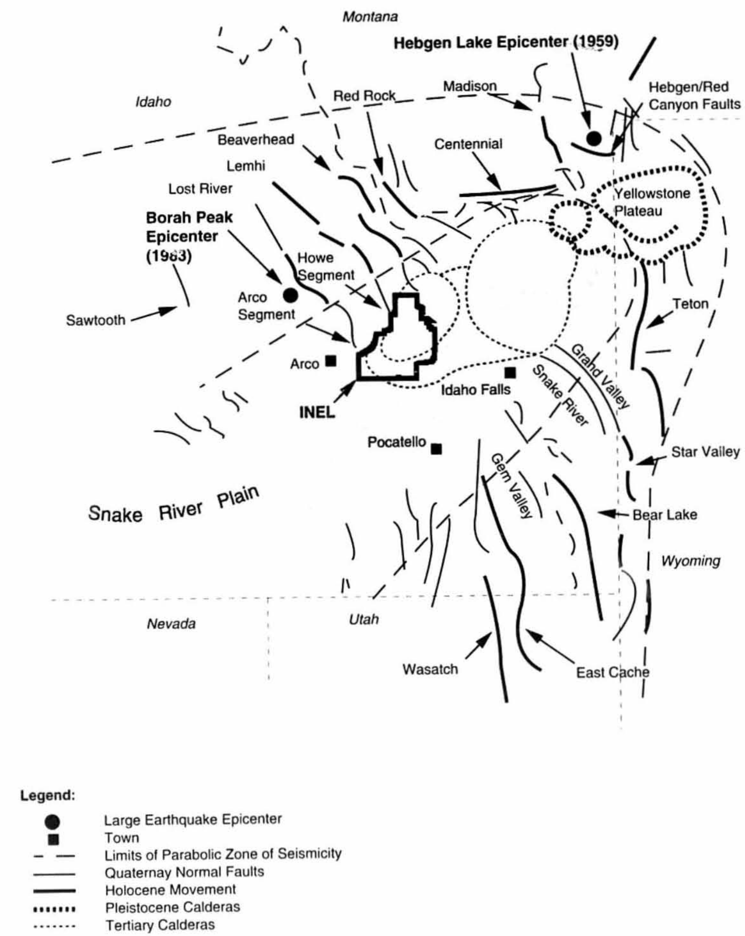
This section describes the geology of the INEL and the surrounding area. Section 4.6.1 characterizes the general geology, while section 4.6.2 describes the natural resources of the area. Sections 4.6.3 and 4.6.4 describe seismic and volcanic hazards, respectively.

4.6.1 General Geology

The site is on the Eastern Snake River Plain (Figure 4.6-1). The Plain forms a broad northeast-trending, crescent-shaped trough with low relief composed primarily of surface basaltic lava flows formed 1.2 million to 2,100 years ago. The Plain features thin, discontinuous, and interbedded deposits of wind-blown loess and sand; water-borne alluvial fan, lacustrine, and floodplain alluvial sediments; and rhyolitic domes formed 1,200,000 to 300,000 years ago (Kuntz et al. 1990) (Figure 4.6-2). Mountains and valleys of the Basin and Range Province, which trend north to northwest and consist of folded and faulted rocks that are more than 70 million years old, bound the Plain on the north and south. The Yellowstone Plateau bounds the Plain on the northeast. The major episode of Basin and Range faulting began 20 to 30 million years ago and continues today, most recently associated with the October 28, 1983, Borah Peak earthquake [moment magnitude 6.9, magnitude 7.3 on the Richter scale with a resulting peak ground acceleration of 0.022 to 0.078 at the INEL (Jackson 1985)], which occurred along the Lost River fault, approximately 100 kilometers (62 miles) from site facilities and the 1959 Hebgen Lake Earthquake, moment magnitude 7.5, approximately 150 kilometers (93 miles) from the INEL (Figure 4.6-1).

The northeast-trending volcanic terrain of the Plain has a markedly different geologic history and tectonic pattern than the folded and faulted terrain of the northwest-trending Basin and Range. The Basin and Range faults have not been observed on or across the Plain. Four northwest-trending volcanic rift zones, attributed to basaltic eruptions that occurred 4 million to 2,100 years ago, lie across the Plain at the INEL (Bowman 1995; Hackett and Smith 1992; Kuntz et al. 1990).

The seismic characteristics of the Eastern Snake River Plain and the adjacent Basin and Range Province are also different. Earthquakes and active faulting are associated with the Basin and Range tectonic activity. The Plain has historically experienced few and small earthquakes (King et al. 1987; Pelton et al. 1990; WCC 1992; Jackson et al. 1993).



Source: Map modified from Anders et al. (1989) and Hackett and Morgan (1988)

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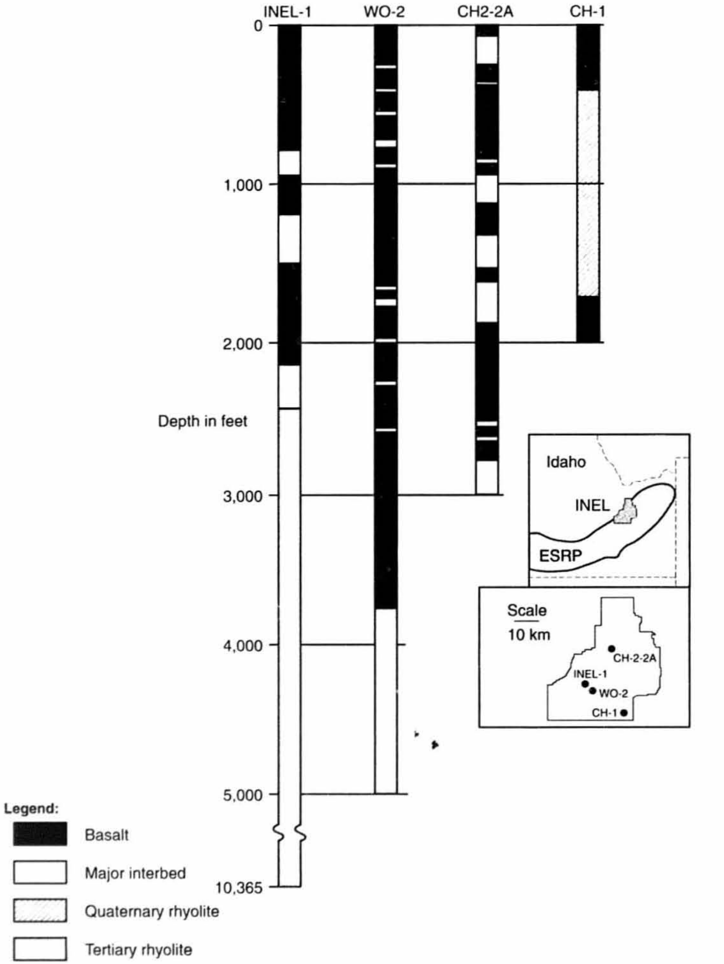
Figure 4.6-1. Location of INEL in context of regional geologic features.



Sources: Doherty (1979a,b), Doherty et al. (1979), Hackett and Smith (1992)

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Figure 4.6-2. Lithologic logs of deep drill holes in the INEL area.

4.6.2 Natural Resources

In 1979 the INEL drilled a geothermal exploration well to 3,159 meters (10,365 feet). Researchers measured a temperature of 142°C (288°F) but identified no commercial quantities of geothermal fluids (IDWR 1980). Mineral resources include several quarries or pits inside the INEL boundary that supply sand, gravel, pumice, silt, clay, and aggregate for road construction and maintenance, new facility construction and maintenance, waste burial activities, and ornamental landscaping cinders. During excavations, DOE might study the gravel pits to characterize the local surficial geology of the site. Outside the site boundary, mineral resources include sand, gravel, pumice, phosphate, and base and precious metals (Strowd et al. 1981; Mitchell et al. 1981). The geologic history of the Plain makes the potential for petroleum production at the INEL very low.

4.6.3 Seismic Hazards

The distribution of earthquakes at and near the INEL from 1884 to 1989 clearly shows that the Plain has a remarkably low rate of seismicity, whereas the surrounding Basin and Range has a fairly high rate (Figure 4.6-3, WCC 1992). The mechanism for faulting and generation of earthquakes in the Basin and Range is attributed to northeast-southwest directed crustal extension.

Several investigators have suggested hypotheses for the low rate of seismic activity within the Plain compared to the activity in both the Centennial Tectonic Belt and the Intermountain Seismic Belt:

- Smith and Sbar (1974) and Brott et al. (1981) suggest that high crustal temperatures beneath the Plain and adjacent region inside the seismic parabola (Figure 4.6-1) result in ductile deformation (aseismic creep), in contrast to the brittle deformation (rock fracture) that occurs in the Basin and Range.

- Anders et al. (1989) suggest that the Plain and the adjacent region inside the seismic parabola (Figure 4.6-1) have increased integrated lithospheric strength. They propose that the presence of mid-crustal basic intrusive rock strengthens the crust so that it is too strong to fracture (see also Smith and Arabasz 1991).

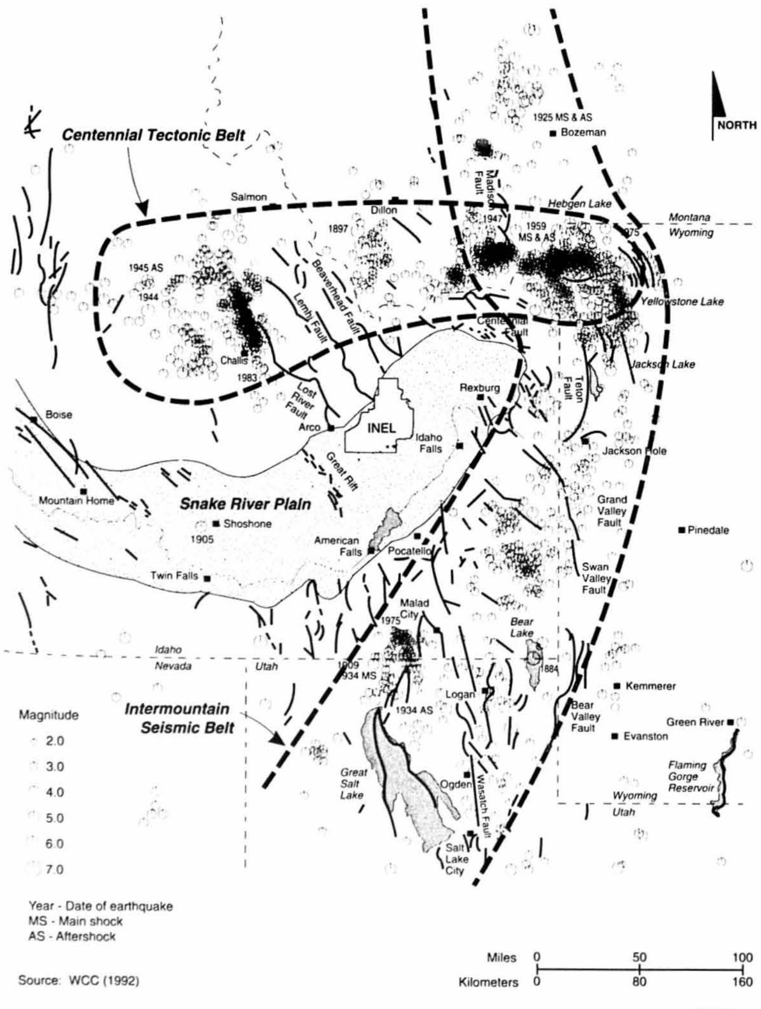

Figure 4.6-3. Earthquakes with magnitudes greater than 2.5 from 1884 to 1989.

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- Parsons and Thompson (1991) propose that magma dike injection suppresses normal faulting and associated seismicity by altering the local tectonic stress field. As dikes are injected in volcanic rift zones, they push apart the surrounding rocks and decrease differential stress, thereby preventing earthquakes from occurring.

- Anders and Sleep (1992) propose that the introduction of mantle-derived magma into the midcrust beneath the Plain has decreased faulting and earthquakes by lowering the rate of deformation.

The markedly different tectonic and seismic histories of the Plain and Basin and Range provinces reflect the dissimilar deformational processes acting in each region. Both regions are subjected to the same extensional stress field (Weaver et al. 1979; Zoback and Zoback 1989; Pierce and Morgan 1992; Jackson et al. 1993); however, crustal deformation occurs through dike injection in the Plain and through large-scale normal faulting in the Basin and Range (Rodgers et al. 1990; Parsons and Thompson 1991; Hackett and Smith 1992).

Major seismic hazards include the effects from ground shaking and surface deformation (faulting, tilting). Other potential seismic hazards (e.g., avalanches, landslides, mudslides, soil settlement, and soil liquefaction) are not likely to occur at the INEL because the local geologic conditions are not conducive to them. Based on the seismic history and the geologic conditions, earthquakes greater than moment magnitude 5.5 (and associated strong ground shaking and surface fault rupture) are not likely to occur in the Plain. However, moderate to strong ground shaking from earthquakes in the Basin and Range can affect the INEL. Researchers use patterns of seismicity and locations of mapped faults to assess potential sources of future earthquakes and to estimate levels of ground motion at the site. The sources and maximum magnitudes of earthquakes that could produce the maximum levels of ground motions at all INEL facilities include the following (WCC 1990; WCC 1992):

- A moment magnitude 7.0 earthquake at the southern end of the Lemhi fault along the Howe and Fallert Springs segments

- A moment magnitude 7.0 earthquake at the southern end of the Lost River fault along the Arco segment

- A moment magnitude 5.5 earthquake associated with dike injection in either the Arco or Lava Ridge-Hell's Half Acre Volcanic Rift Zone and the Axial Volcanic Zone

- A "random" moment magnitude 5.5 earthquake occurring in the Eastern Snake River Plain

Figure 4.6-4 shows a facility-specific example of the relationship of the peak ground acceleration on the INEL to the annual frequency of occurrence of seismic events on various seismic sources in the region, including the four events described above (WCFS 1993). The curves refer specifically to the site of the Idaho Chemical Processing Plant in the south-central INEL and might not apply directly to other INEL areas. Ground motion contributions from seismic sources not shown on Figure 4.6-4 (i.e., Intermountain seismic belt and Yellowstone Region) are significantly smaller because of their distant locations or lower estimated maximum magnitudes. The INEL Natural Phenomena Committee determines INEL seismic design-basis events based on studies such as those performed by Woodward Clyde Consultants (1990) and Woodward Clyde Federal Services (1993).

A maximum horizontal ground surface acceleration of 0.24*g* at the Idaho National Engineering Laboratory is estimated to result from an earthquake that could occur once every 2,000 years (DOE 1994). The seismic hazard information presented in this EIS is for general seismic hazard comparisons across DOE sites. Potential seismic hazards for existing and new facilities should be evaluated on a facility-specific basis, consistent with DOE orders, standards, and site-specific procedures. Section 5.15 describes the potential impacts of postulated seismic events.

4.6.4 Volcanic Hazards

Volcanic hazards at the INEL can come from sources inside or outside Plain boundaries. These hazards include the effects of lava flows, ground deformation (fissures, uplift, subsidence), volcanic earthquakes (associated with magmatic processes as distinct from earthquakes associated with tectonics), and ash flows or airborne ash deposits (Bowman 1995). Most of the basalt volcanic activity occurred from 4 million to 2,100 years ago in the INEL area. The most recent and closest volcanic eruption occurred 2,100 years ago at the Craters of the Moon, 25 kilometers (15 miles) southwest of the INEL (Kuntz et al. 1992). The rhyolite domes along the Axial Volcanic Zone formed between 1.2 million and 300,000 years ago and have a recurrence interval of about 200,000 years. Therefore, the probability of future dome formation affecting INEL facilities is very low.

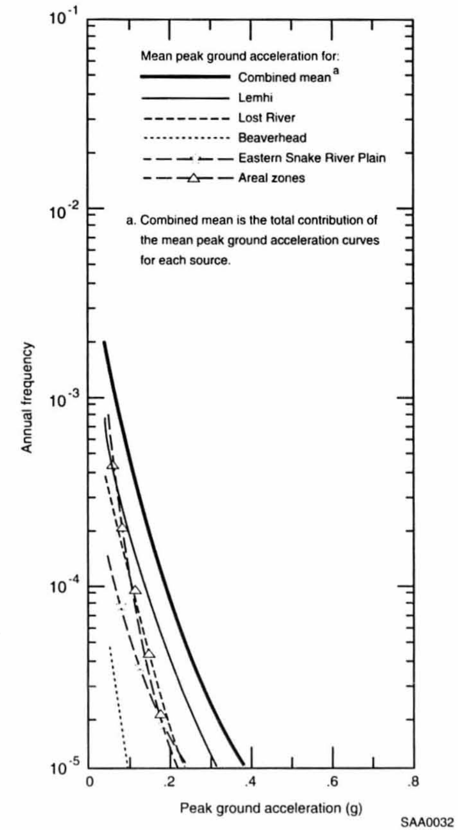

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Figure 4.6-4. Contribution of the seismic sources to the mean peak acceleration at the Idaho Chemical Processing Plant.

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Catastrophic Yellowstone eruptions have occurred three times in the past 2 million years, but the INEL is more than 160 kilometers (70 miles) from the Yellowstone Caldera rim and high-altitude winds would not disperse Yellowstone ash in the direction of INEL. Due to the infrequency, great distance, and unfavorable dispersal, pyroclastic flows or ash fallout from future Yellowstone eruptions should not impact the INEL.

Basaltic lava flows and eruptions from fissures or vents might occur. Based on a probability analysis of the volcanic history in the Big Southern Butte area (Volcanism Working Group 1990), the conditional probability that basaltic volcanism would affect a south-central INEL location is less than 2.5×10^{-5} per year (once per 40,000 years or longer), where the risk associated with Axial Volcanic Zone volcanism is greatest. The estimated probability of volcanic impact on INEL facilities farther north, where both silicic and basaltic volcanism have been older and less frequent, is less than 10^{-6} per year (once every million years or longer). The statistics of 116 measured INEL-area lava flow lengths and areas were used to define the two lava flow hazard zones (Figure 4.6-5). The hazard for a particular site within or near a volcanic zone is much lower, typically by an order of magnitude or more, and must be assessed on a site-specific basis (Bowman 1995).

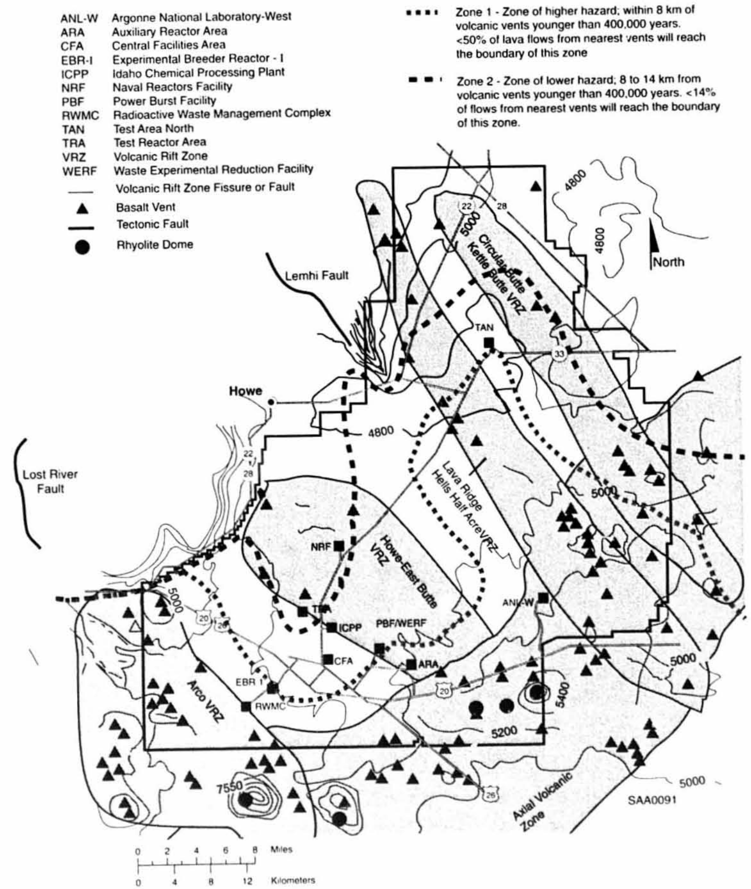

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Figure 4.6-5. Map of the INEL showing locations of volcanic rift zones and lava flow hazard zones.

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4.7 Air Quality

This section describes the air resources of the INEL site and the surrounding area. The discussion includes the climatology and meteorology of the region, descriptions of nonradiological and radiological air contaminant emissions, and a characterization of existing and projected levels of air pollutants. The analysis includes both existing facilities and those that were expected (at the time the analysis was performed) to be operational before June 1, 1995. Additional detail and background information on the material presented in this section is presented in Appendix F, Section F-3, of Volume 2.

4.7.1 Climatology and Meteorology

The Eastern Snake River Plain climate exhibits low relative humidity, wide daily temperature swings, and large variations in annual precipitation. Average seasonal temperatures measured on the INEL site range from -7.3°C (18.8°F) in winter to 18.2°C (64.8°F) in summer, with an annual average temperature of about 5.6°C (42°F). Temperature extremes range from a summertime maximum of 39.4°C (103°F) to a wintertime minimum of -45°C (-49°F). The annual average relative humidity is 50 percent, with monthly average maximum values ranging from 59 percent in July to 89 percent in February and December, and with monthly average minimum values ranging from 16 percent in June and July to 47 percent in January (Clawson et al. 1989).

Annual precipitation is light, averaging 221.2 millimeters (8.71 inches), with monthly extremes of zero to 127 millimeters (5 inches). The maximum 24-hour precipitation rate is 46 millimeters (1.8 inches). The greatest short-term precipitation rates are attributable primarily to thunderstorms, which occur approximately two or three days per month during the summer. The average annual snowfall is 701 millimeters (27.6 inches), with a maximum of 1,516 millimeters (59.7 inches) and a minimum of 173 millimeters (6.8 inches) (Clawson et al. 1989).

The INEL site is in the belt of prevailing westerlies; however, the mountain ranges bordering the Eastern Snake River Plain normally channel these winds into a southwest wind. Most offsite locations experience the predominant southwest-northeast wind flow of the Eastern Snake River Plain, although subtle terrain features near some locations cause considerable variations from this flow regime. The annual average wind speed measured at the 6.1-meter (20-foot) level at the Central Facilities Area Weather Station is 3.4 meters per second (7.5 miles per hour). Monthly average values range from

2.3 meters per second (5.1 miles per hour) in December to 4.2 meters per second (9.3 miles per hour) in April and May (Clawson et al. 1989). The highest hourly average near-ground wind speed measured onsite is 22.8 meters per second (51 miles per hour) from the west-southwest, with a maximum instantaneous gust of 34.9 meters per second (78 miles per hour) (Clawson et al. 1989). Figure 4.7-1 presents the frequency of wind speed and wind direction at three meteorological monitoring sites on the INEL site from 1988 to 1992. The wind directions presented in the figure are the direction from which the wind blows. The three wind-roses demonstrate the effects of terrain on predominant wind directions and wind speed. The winds at the Test Area North monitoring station are predominantly from the north-northwest, whereas the winds from the other stations are predominantly from the southwest.

Air pollutant dispersion is a result of the processes of transport and diffusion of airborne contaminants in the atmosphere. Transport is the movement of a pollutant in the wind field, while diffusion refers to the process whereby turbulent eddies dilute a pollutant plume. The temperature gradient of the atmosphere (i.e., the change in temperature with altitude) can restrict or enhance the vertical diffusion of pollutants. Lapse rate conditions, which tend to enhance vertical diffusion, occur slightly less than 50 percent of the time. Conversely, thermal stratification or inversion conditions, which inhibit vertical diffusion, occur slightly more than 50 percent of the time. The height to which the pollutants can freely diffuse is the mixing depth, while the layer of air from the ground to the mixing depth is the mixed layer. Estimates of the monthly average depth of the mixed layer range from 400 meters (1,312 feet) in December to 3,000 meters (9,843 feet) in July. With calm winds and mostly clear skies, nocturnal inversions begin forming after sunset and dissipate about 1 to 2 hours after sunrise. These inversions are often ground-based, meaning the atmospheric temperature increases with height from the ground (Clawson et al. 1989).

Other than thunderstorms, severe weather is uncommon. Five funnel clouds (tornadoes not touching the ground) and no tornadoes were reported on the site between 1950 and 1988. Visibility in the region is good because of the low moisture content of the air and minimal sources of visibility-reducing pollutants. From Craters of the Moon National Monument, the seasonal visual range is from 130 to 155 kilometers (81 to 97 miles) (Notar 1993).

4.7.2 Air Quality

4.7.2.1 Nonradiological Air Quality. The INEL is in the Eastern Idaho Intrastate Air Quality Control Region (AQCR 61). Neither the INEL nor any of the surrounding counties is

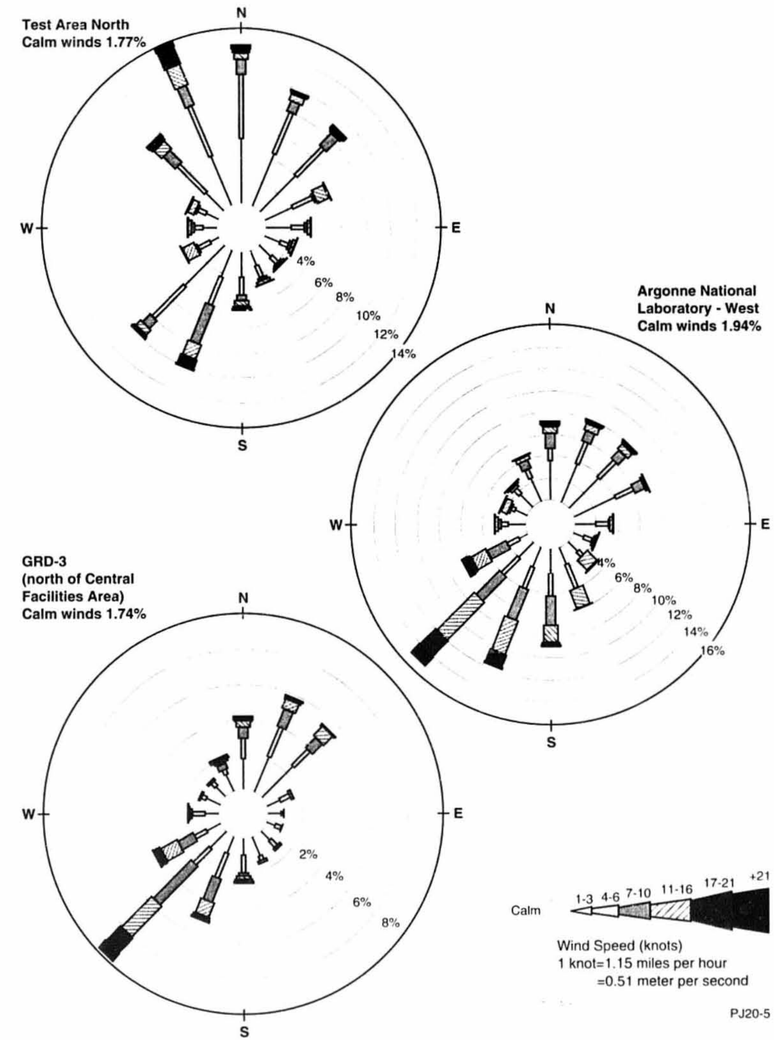

Figure 4.7-1. Depiction of annual average wind direction and speed at INEL meteorological monitoring stations.

designated as a nonattainment area (CFR 1992b) for the National Ambient Air Quality Standards (CFR 1991b). Ambient air quality data monitored in the vicinity of the INEL indicate that the site is in compliance with applicable air quality standards (DOE 1991a).

The Clean Air Act (CAA 1990) contains requirements to prevent the deterioration of air quality in areas designated to be in attainment with the ambient air quality standards. These requirements are administered through a program that limits the increase in specific air pollutants above the levels that existed in what has been termed a baseline (or starting) year, which is 1977. The requirements specify maximum allowable ambient pollutant concentration increases or increments. They specify increment limits for pollutant level increases for the nation as a whole (Class II areas) and prescribe more stringent increment limits (as well as ceilings) for designated national resources, such as national forests, parks, and monuments (Class I areas). Three areas in the INEL vicinity are Prevention of Significant Deterioration Class I ambient air quality areas: Craters of the Moon Wilderness Area, approximately 53 kilometers (33 miles) to the west-southwest; Yellowstone National Park, approximately 143 kilometers (89 miles) to the northeast; and Grand Teton National Park, approximately 145 kilometers (90 miles) to the east-northeast.

DOE evaluates proposed new and modified sources of emissions at INEL to determine the net emissions increase of all pollutants. The INEL is considered a major source, because facility-wide emissions of specific regulated air contaminants exceed 227 metric tons (250 tons) per year. Therefore, a Prevention of Significant Deterioration analysis must be performed for all significant emission increases of specified regulated pollutants. Levels of significance for net emission increases range from very small quantities (less than 1 pound) for beryllium up to 91 metric tons (100 tons) per year for carbon monoxide. Their significance is dependent on the toxicity of the substance. For radionuclides, significance means any increase in emissions that would result in an offsite dose of 0.1 millirem per year or greater.

Ambient air quality standards for Idaho are the same as the National Ambient Air Quality Standards but include total suspended particulates and fluorides. The Idaho Department of Health and Welfare (IDHW) also has ambient concentration limits for hazardous and toxic air pollutants. Table 4.7-1 lists emission rates of criteria and hazardous and toxic air pollutants.

The types and amounts of nonradiological emissions from INEL facilities and activities are similar to those from other industrial complexes that are the same sizes as the INEL. Combustion sources such as boilers and emergency generators emit both criteria and toxic pollutants. Other

Table 4.7-1. Baseline annual average and maximum hourly emission rates of nonradiological air pollutants at the INEL.[a]

Pollutant	Annual average (kg/yr)[b,c]	Maximum hourly (kg/hr)[b]
Criteria pollutants		
Carbon monoxide (CO)	301,000	177
Lead (Pb)	11	0.085
Nitrogen dioxide (NO_2)	744,000	545
Particulate matter (PM_{10})[d]	302,000	230
Sulfur dioxide (SO_2)	202,000	136
Hazardous/toxic air pollutants[e]		
Acetaldehyde	31	0.39
Ammonia	1,600	3.4
Arsenic	4.2	9.0×10^{-4}
Benzene	370	16
1,3-Butadiene	220	0.8
Carbon tetrachloride	28	0.08
Chloroform	1.9	5.5×10^{-3}
Chromium - trivalent	3.1	2.5×10^{-3}
Chromium - hexavalent	0.4	6.2×10^{-4}
Cyclopentane	350	0.58
Dichloromethane	620	0.29
Formaldehyde	960	8.9
Hydrazine	8.3	9.5×10^{-4}
Hydrochloric acid	1,500	0.34
Mercury	200	0.023
Napthalene	16	2.2
Nickel	270	0.057
Nitric acid	1,500	1.7
Phosphorous	56	0.024
Potassium hydroxide	990	0.24
Propionaldehyde	62	0.24
Styrene	4.7	0.74
Tetrachlorethylene	980	0.11
Toluene	580	56
Trichloroethylene	4.7	0.013
Trimethylbenzene	87	12

a. Source: Volume 2, Table 4.7-2.
b. To convert kilograms to pounds, multiply by 2.2.
c. Annual average values include actual emissions plus projected increases from facilities that will become opertional after the baseline year.
d. It is conservatively assumed that all particulate matter is PM_{10} (less than 10 microns in diameter).
e. Hazardous/toxic air pollutants that are listed in State of Idaho regulations and are emitted in levels that exceed screening criteria.

sources include chemical processing operations, transportation, waste management activities, and research laboratories.

Table 4.7-2 compares the INEL contribution to air quality to applicable standards and guidelines. This assessment modelled the INEL air emissions inventory for 1990 using the methodology approved by the U.S. Environmental Protection Agency to predict the maximum ground-level concentration that would occur at or beyond the site boundary for each regulated pollutant (EPA 1993b). The Industrial Source Complex-2 model primarily assessed criteria pollutants, and the SCREEN model assessed toxic air pollutants. The SCREEN model incorporates meteorological data that tend to overestimate impacts, and is useful for identifying cases that require additional, more refined assessments. The baseline concentrations listed in Table 4.7-2 are the sums of the following factors: the concentrations resulting from potential impacts from current operations and the concentrations resulting from the construction or operation of planned upgrades or modifications before the implementation of the proposed actions described in Section 5.7. Background concentrations have not been included because (a) reliable data on background levels in the INEL environs are not available for most pollutants and (b) background levels are low and are more than offset by the use of the maximum (as opposed to actual) baseline. The baseline concentrations represent the maximum calculated concentration occurring at public access locations (site boundary, public roads, and Craters of the Moon Wilderness Area). A comparison of the baseline concentrations to applicable Federal and state criteria pollutant and hazardous/toxic air pollutant guidelines and regulations shows that air quality at INEL is in compliance with those guidelines and regulations. The 24-hour total suspended particulate background concentration is listed as 40 micrograms per cubic meter, which is the same as the annual geometric mean value. The annual sources include chemical processing operations, transportation, waste management activities, and research laboratories.

4.7.2.2 Radiological Air Quality. The major source of radiation exposure in the Eastern Snake River Plain is from natural background radiation sources such as cosmic rays; radioactivity naturally present in soil, rocks, and the human body; and airborne radionuclides of natural origin (such as radon). Sources of radioactivity related to INEL operations include research and training reactors, spent nuclear fuel testing and stabilization, irradiated material and fuel examination, nuclear waste treatment and storage, and depleted uranium armor production.

Radioactive emissions from INEL facilities include the noble gases (argon, krypton, and xenon) and iodine; particulate fission products such as rubidium, strontium, and cesium; radionuclides formed

Table 4.7-2. Comparison of baseline ambient air concentrations with most stringent applicable regulations and guidelines at the INEL.

Pollutant	Averaging time	Most stringent regulation or guideline ($\mu g/m^3$)^{a,b,c}	Maximum baseline concentration ($\mu g/m^3$)	Percent of standard
Criteria pollutants				
Carbon monoxide (CO)	8-hour	10,000	280	2.8
	1-hour	40,000	610	1.5
Lead (Pb)	Calendar Quarter	1.5	0.001	<0.1
Nitrogen dioxide (NO_2)	Annual	100	4	4
Particulate matter (PM_{10})	Annual	50	5	10
	24-hour	150	80	53
Sulfur dioxide (SO_2)	Annual	80	6	7.5
	24-hour	365	140	37
	3-hour	1,300	580	45
Hazardous/toxic air pollutants				
Acetaldehyde	Annual	4.5×10^{-1}	1.1×10^{-2}	2
Ammonia	Annual	1.8×10^{2}	6.0×10^{0}	3
Arsenic	Annual	2.3×10^{-4}	9.0×10^{-5}	39
Benzene	Annual	1.2×10^{-1}	2.9×10^{-2}	24
Butadiene	Annual	3.6×10^{-3}	1.0×10^{-3}	28
Carbon Tetrachloride	Annual	6.7×10^{-2}	6.0×10^{-3}	9
Chloroform	Annual	4.3×10^{-2}	4.0×10^{-4}	<1
Chromium - hexavalent	Annual	8.3×10^{-5}	6.0×10^{-5}	72
Chromium - trivalent	Annual	5.0×10^{0}	3.6×10^{-2}	<1
Cylclopentane	Annual	1.7×10^{4}	2.7×10^{-0}	<1
Formaldehyde	Annual	7.7×10^{-2}	1.2×10^{-2}	16
Hydrazine	Annual	3.4×10^{-4}	1.0×10^{-6}	<1
Hydrochloric acid	Annual	7.5×10^{0}	9.8×10^{-1}	13
Mercury	Annual	1.0×10^{0}	4.2×10^{-2}	4
Methylene Chloride	Annual	2.4×10^{-1}	6.0×10^{-3}	3
Napthalene	Annual	5.0×10^{2}	1.8×10^{1}	4
Nickel	Annual	4.2×10^{-3}	2.7×10^{-3}	65
Nitric Acid	Annual	5.0×10^{1}	6.4×10^{-1}	1

Table 4.7-2. (continued).

Pollutant	Averaging time	Most stringent regulation or guideline ($\mu g/m^3$)[a,b,c]	Maximum baseline concentration ($\mu g/m^3$)	Percent of standard
Perchloroethylene	Annual	2.1×10^0	1.1×10^{-1}	5
Phosphorous	Annual	1.0×10^0	3.0×10^{-1}	30
Potassium hydroxide	Annual	2.0×10^1	2.0×10^{-1}	1
Proprionaldehyde	Annual	4.3×10^0	3.0×10^{-1}	7
Styrene	Annual	1.0×10^3	1.3×10^0	<1
Toluene	Annual	3.8×10^3	3.7×10^2	10
Trichloroethylene	Annual	7.7×10^{-2}	9.7×10^{-4}	1
Trimethylbenzene	Annual	1.2×10^3	1.0×10^2	8

a. CFR (1991b).
b. IDHW (1994); the ambient standards for the criteria pollutants are the same as the NAAQS.
c. Standards cited for hazardous/toxic air pollutants are for all new sources constructed or modified since May 1, 1994, under State of Idaho Regulations for the Control of Air Pollution in the State of Idaho (IDHW 1994).
Source: Volume 2, Section 4.7.

by neutron activation such as tritium (hydrogen-3), carbon-14, and cobalt-60; and very small quantities (less than 6×10^{-4} curies per year) of heavy elements such as uranium, thorium, plutonium, and their decay products. Historically, the radionuclide with the highest emission rate is the noble gas krypton-85, which is released primarily by the chemical reprocessing of spent nuclear fuel at the Idaho Chemical Processing Plant. Fuel reprocessing also releases small amounts (less than 0.1 curie per year) of iodine-129, which is of concern because of its long half-life (16 million years) and biological properties (iodine isotopes tend to accumulate in the human thyroid). Reactor operations release noble gas isotopes with short half-lives, including argon-41 and isotopes of xenon (primarily xenon-133, -135, and -138). Other activities at the INEL, including waste management operations, result in very low levels of airborne radionuclide emissions (less than 1×10^{-4} curie per year). Table 4.7-3 summarizes airborne radionuclide emissions from INEL facility areas, plus estimated emissions from projects expected, at the time of the analysis was performed, to become operational before June 1, 1995.

Radioactivity released to the atmosphere can result in human exposure through a number of pathways, including inhalation, external exposure, and ingestion. DOE conducts physical

Table 4.7-3. Summary of airborne radionuclide emissions from INEL facility areas (curies per year).[a]

Facility	Tritium/ carbon-14	Iodines	Noble gases	Mixed fission and activation products[b]	U/Th/TRU[c]
Argonne National Laboratory-West	1.0×10^2	—[d]	1.3×10^4	8.1×10^{-4}	1.8×10^{-6}
Central Facilities Area	2.6×10^0	5.0×10^{-7}	—	1.9×10^{-5}	9.6×10^{-7}
Idaho Chemical Processing Plant	4.3×10^1	6.4×10^{-2}	1.0×10^4	3.6×10^{-2}	9.4×10^{-9}
Naval Reactors Facility	1.9×10^{-1}	6.3×10^{-6}	5.7×10^{-1}	5.6×10^{-5}	—
Power Burst Facility/Waste Experimental Reduction Facility	4.9×10^1	—	—	1.3×10^0	9.8×10^{-3}
Radioactive Waste Management Complex	—	—	—	2.6×10^{-5}	4.2×10^{-6}
Test Area North	1.2×10^{-1}	—	—	5.6×10^{-6}	1.5×10^{-5}
Test Reactor Area	1.6×10^2	1.6×10^{-2}	3.3×10^3	3.0×10^0	1.8×10^{-6}
INEL total	2.1×10^3	1.1×10^{-1}	1.2×10^5	5.6×10^0	1.0×10^{-2}

a. With the exception of the Idaho Chemical Processing Plant, emissions estimates are based on 1991 operations. Idaho Chemical Processing Plant emissions are based on 1993 emissions but are scaled upward to reflect operation of the New Waste Calcining Facility at maximum permitted levels. Anticipated projects in the baseline include the Waste Experimental Reduction Facility (compacting and sizing operations but not incineration), Argonne National Laboratory-West Fuel Cycle Facility, and Portable Water Treatment Unit, as described in Appendix F of Volume 2.
b. Mixed fission and activation products that are primarily particulate in nature (for example, cobalt-60, strontium-90, and cesium-137).
c. U/Th/TRU = Radioisotopes of uranium, thorium, or transuranic elements such as plutonium, americium, and neptunium.
d. A dash (—) indicates that the emissions for this group are negligibly small or zero.
Source: Volume 2, Table 4.7-1.

measurements (ambient air monitoring) and uses calculation techniques (atmospheric dispersion modeling) to assess existing levels of radiation (both cosmic and manmade) in and near the site, and to assess doses to workers and the surrounding population.

The offsite population can receive a radiation dose as a result of radiological conditions directly attributable to existing INEL operations. DOE assesses such a dose for a maximally exposed individual and for the population as a whole. The maximally exposed individual is a hypothetical person whose habits and proximity to the site are such that the person would receive the highest dose projected to result from sitewide radioactive emissions. The calculated annual dose to this individual as a result of current and anticipated sitewide emissions is 0.05 millirem (Section 4.7 to Volume 2). This value is a small fraction of both the National Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year (CFR 1992a) and the dose received from natural background sources of 351 millirem per year (Section 4.7 to Volume 2). Figure 4.7-2 compares these dose rates.

The collective annual dose to the surrounding population, determined using 1990 U.S. Census Bureau data for the total population residing within an 80-kilometer (50-mile) radius from each facility on the site, is about 0.3 person-rem (Section 4.7 to Volume 2). This value is small in comparison to the annual dose received by the same population from background sources, which is more than 40,000 person-rem (Section 4.7 to Volume 2).

Workers at each major INEL facility can receive radiation exposures. DOE has based its assessment of the dose to these workers on contributions from sources at each facility and those expected to become operational before June 1, 1995. The results of this assessment indicate that the maximum dose received by a worker at any onsite area is about 4.3 millirem per year (Section 4.7 to Volume 2), well below the National Emissions Standard for Hazardous Air Pollutants dose limit of 10 millirem per year. The standard applies to the highest exposed member of the public, and is not applicable to workers. However, it is the most restrictive limit for airborne releases and provides a useful comparison. This dose value of 4.3 millirem per year includes the maximum projected operation of the Portable Water Treatment Unit at the Power Burst Facility Area. However, that operation would be temporary (1 to 2 years) and is not representative of a permanent increase in the baseline. If this facility were not included, the baseline dose to the worker would be about 0.2 millirem per year.

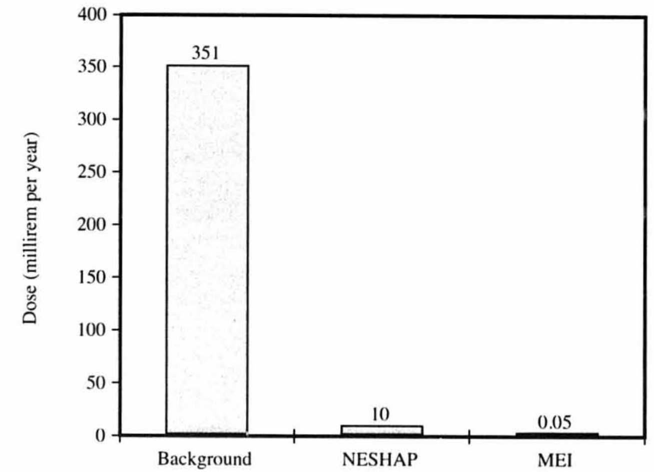

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Figure 4.7-2. Comparison of dose to maximally exposed individual to the National Emission Standard for Hazardous Air Pollutants dose limit and the dose from background sources.

4.8 Water Resources

This section describes existing regional and site hydrologic conditions and discusses the quality of surface and subsurface water and water use and rights. The subsurface water section also describes the vadose zone (or unsaturated zone and perched water bodies) located between the land surface and the water table.

4.8.1 Surface Water

Other than surface-water bodies formed from accumulated runoff during snowmelt or heavy precipitation and manmade infiltration and evaporation ponds, there is little surface water at the site. The following sections discuss regional drainage conditions, local runoff, floodplains, and surface-water quality. Figure 4.8-1 supports discussions in this section.

4.8.1.1 Regional Drainage. The INEL is in the Pioneer Basin, a closed drainage basin that includes three main surface-water bodies--the Big and Little Lost Rivers and Birch Creek. These water bodies drain mountain watersheds directly west and north of the site. However, most of the surface-water flow is diverted for irrigation before it reaches site boundaries (Barraclough et al. 1981), resulting in little or no flow for several years inside the site boundaries (Pittman et al. 1988).

The Big Lost Piver drains approximately 3,755 square kilometers (1,450 square miles) of land before reaching the site. Approximately 48 kilometers (30 miles) upstream of Arco, Idaho, Mackay Dam controls and regulates the flow of the river, which continues southeast past the towns of Moore and Arco and onto the Eastern Snake River Plain. The river channel then crosses the southwestern boundary of the site, where the INEL Diversion Dam controls surface-water flow. During heavy runoff events, the dam diverts surface water to a series of natural depressions, designated as spreading areas. The Big Lost River continues northeasterly across the site to an area of natural infiltration basins (playas or sinks) near Test Area North. In dry years, surface water does not usually reach the western boundary of the site, and because the INEL is located in a closed drainage basin, surface water never flows off the site.

Birch Creek drains an area of approximately 1,943 square kilometers (750 square miles). In the summer, upstream of the site, surface water from Birch Creek is diverted to provide irrigation and

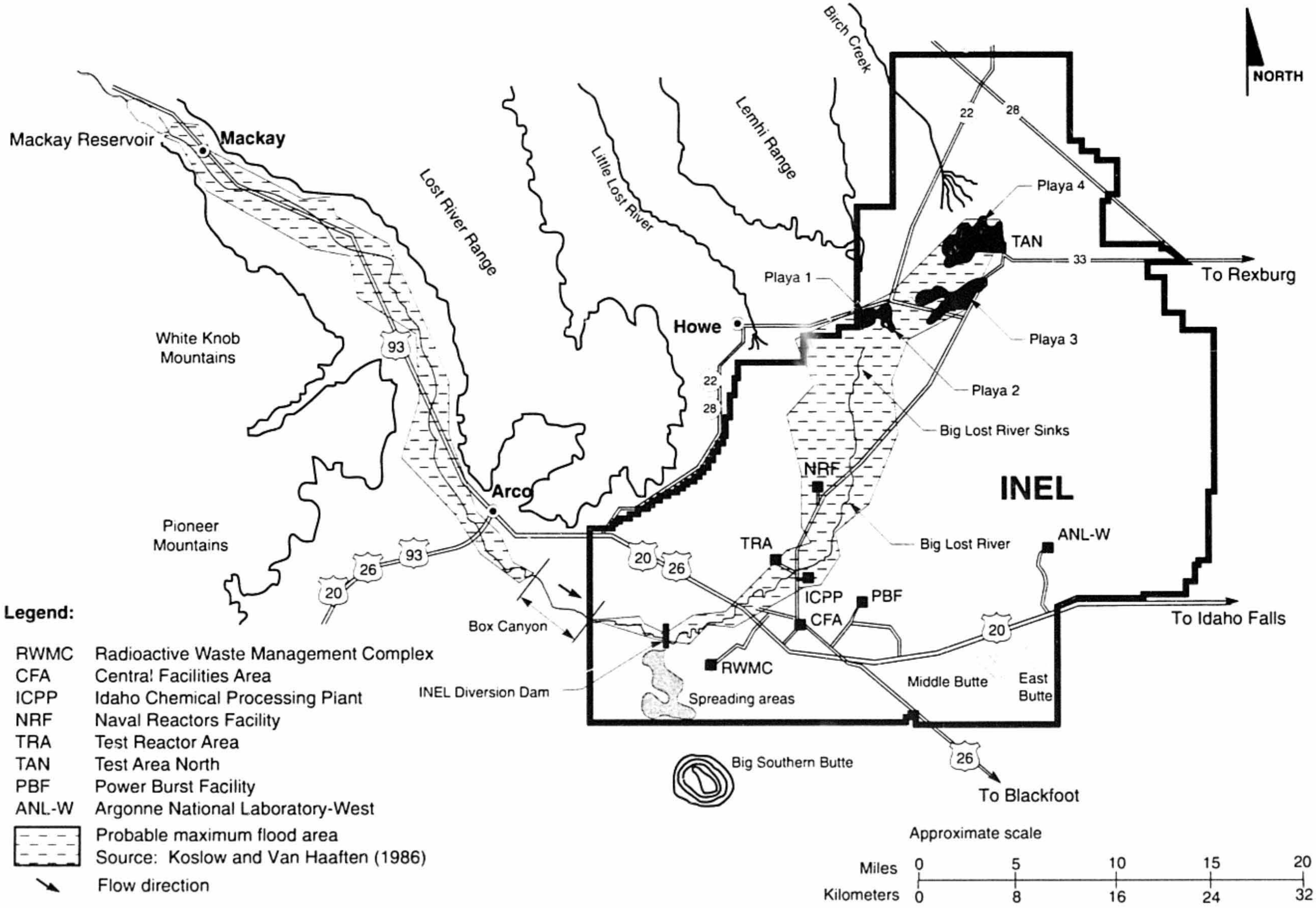

Figure 4.8-1. Selected facilities and predicted inundation map for probable maximum flood-induced overtopping failure of Mackay Dam at the INEL.

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to produce hydropower. In the winter, water flow crosses the northwest corner of the site, entering a manmade channel 6.4 kilometers (4 miles) north of Test Area North, where it then infiltrates into channel gravels.

The Little Lost River drains an area of approximately 1,826 square kilometers (705 square miles). Streamflow is diverted for irrigation north of Howe, Idaho Surface water from the Little Lost River has not reached the site in recent years; however, during high stream flow years, water will reach the site and infiltrate into the subsurface (EG&G 1984).

4.8.1.2 Local Runoff. Surface water generated from local precipitation will flow into topographic depressions (lower elevations than the surrounding terrain) on the site. This surface water either evaporates or infiltrates into the ground, increasing subsurface saturation and enhancing subsurface migration (Wilhelmson et al. 1993).

Localized flooding can occur at the site when the ground is frozen and melting snow combines with heavy spring rains. Test Area North was flooded in 1969 (Koslow and Van Haaften 1986). In 1969 extensive flooding caused by snowmelt occurred in the lower Birch Creek Valley (Koslow 1984). Studies have shown that both the 25- and 100-year, 24-hour rainfall/snowmelt storm event could cause flooding within the Radioactive Waste Management Complex (Dames & Moore 1992). The drainage system, including dikes and erosion prevention features designed to mitigate potential surface water flooding, are being upgraded.

4.8.1.3 Floodplains. Intermittent surface-water flow and the INEL Diversion Dam (built in 1958 and enlarged in 1984) have effectively prevented flooding from the Big Lost River onto the site. However, onsite flooding from the river could occur if high water in the Mackay Dam or the Big Lost River were coupled with a dam failure. Koslow and Van Haaften (1986) examined the consequences of structural failure of the Mackay Dam due to a seismic event, coupled with a probable maximum flood (the largest flood assumed possible in an area). This scenario predicts flood waters overtopping the INEL Diversion Dam and spreading at the Idaho Chemical Processing Plant, Naval Reactors Facility, and the Test Area North Loss-of-Fluid Test Facility (Figure 4.8-1). In the event of a combined Mackay Dam failure and a 100-year flood (flood that occurs on an average of every 100 years), flooding along the Big Lost River would also occur, with low velocities and water depths on the INEL (Koslow and Van Haaften 1986). The area inundated under the Mackay Dam failure scenarios probably would use more than the 100- or 500-year floodplains for the Big Lost River at the INEL. A 100-year floodplain study for the INEL is in progress.

4.8.1.4 Surface-Water Quality. Water quality in the Big and Little Lost Rivers and Birch Creek is similar and has not varied a great deal over the period of record. Measured physical, chemical, and radioactive parameters have not exceeded applicable drinking water quality standards. Chemical composition is determined primarily by the mineral composition of the rocks in the mountain ranges northwest of the site and by the chemical composition of irrigation water in contact with the surface water (Robertson et al. 1974; Bennett 1990).

Site activities do not directly affect the quality of surface water outside the site because discharges from site facilities are to manmade seepage and evaporation basins or stormwater injection wells. Effluents are not discharged to natural surface waters. In addition, surface water does not flow directly off the site (Hoff et al. 1990). However, water from the Big Lost River, as well as seepage from evaporation basins and stormwater injection wells, does infiltrate the Snake River Plain Aquifer (Robertson et al. 1974; Wood and Low 1988; Bennett 1990). These areas are inspected, monitored, and sampled as stipulated in the INEL Stormwater Pollution Prevention Program (DOE-ID 1993b).

4.8.2 Subsurface Water

Subsurface water at the site occurs in the Snake River Plain Aquifer and the vadose zone. This section describes regional and local hydrogeologic conditions, vadose zone hydrology, perched water, and subsurface-water quality. Generally, the term "groundwater" refers to usable quantities of water that enter freely into wells under confined and unconfined conditions within an aquifer (Driscoll 1989).

4.8.2.1 Regional Hydrogeology. The INEL overlies the Snake River Plain Aquifer, the largest aquifer in Idaho (Figure 4.8-2). This aquifer underlies the Eastern Snake River Plain and covers an area of approximately 24,900 square kilometers (9,611 square miles). Groundwater in the aquifer generally flows south and southwestward across the Snake River Plain. The estimated water storage in the aquifer is 2.5×10^{12} cubic meters (2 billion acre-feet, which is about the same as the volume of water contained in Lake Erie) (Robertson et al. 1974). A typical irrigation well can yield as much as 13.9×10^{6} cubic meters (3.7×10^{9} gallons) per year of water if pumped every day (Garabedian 1989). The Snake River Plain Aquifer is among the most productive aquifers in the nation.

The drainage basin recharging the Snake River Plain Aquifer covers an area of approximately 90,643 square kilometers (35,000 square miles). The aquifer is recharged by infiltration of irrigation

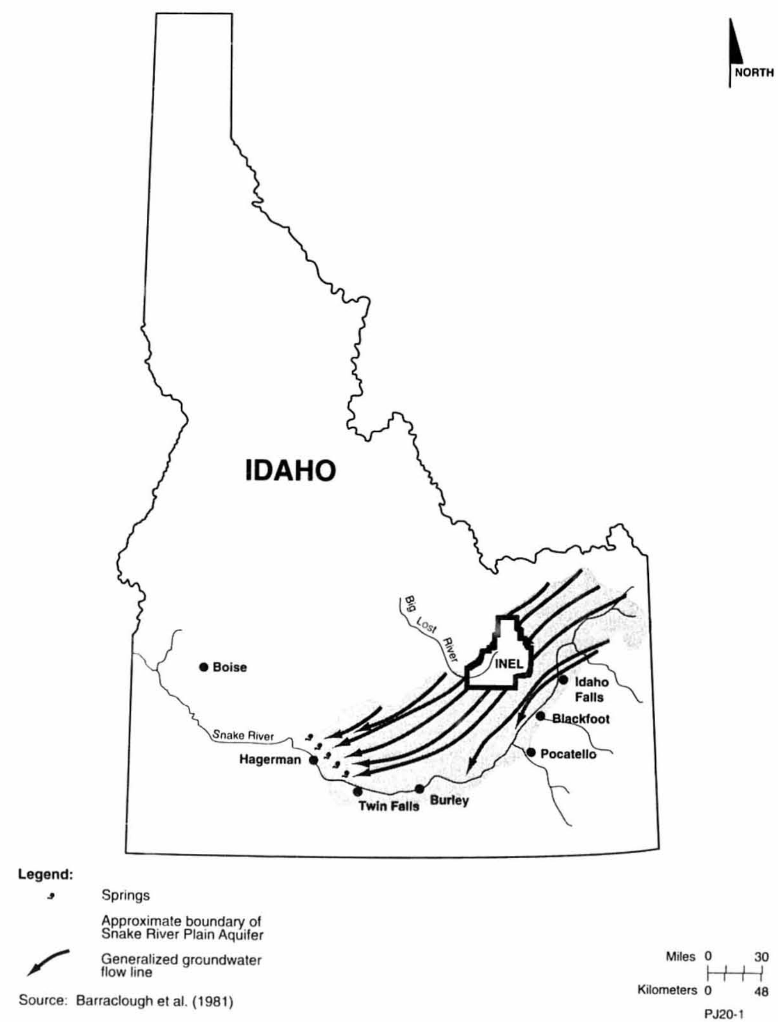

Figure 4.8-2. Location of the INEL, Snake River Plain, and generalized groundwater flow direction of the Snake River Plain Aquifer.

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water, seepage from stream channels and canals, underflow from tributary stream valleys extending into the watershed, and direct infiltration from precipitation (Garabedian 1989). Most recharge occurs in surface water-irrigated areas and along the northeastern margins of the plain. Groundwater discharges primarily from the aquifer through springs that flow into the Snake River and from pumping for irrigation. Major springs and seepages that flow from the aquifer are located near the American Falls Reservoir (southwest of Pocatello) and the Thousand Springs area between Milner Dam and King Hill (near Twin Falls).

4.8.2.2 Local Hydrogeology. The INEL site covers 2,305 square kilometers (890 square miles) of the north-central portion of the Snake River Plain Aquifer. Depth to groundwater from the land surface at the site ranges from approximately 61 meters (200 feet) in the north to over 274 meters (900 feet) in the south (Pittman et al. 1988) (see Figure 4.8-3). Groundwater flow is generally toward the south-southwest, and the upper surface is primarily unconfined (not overlain by impermeable soil or bedrock). However, the aquifer behaves as if it were partially confined because of localized geologic conditions. The occurrence and movement of groundwater in the aquifer depends on the geologic setting and the recharge and discharge of water within that setting. Most of the aquifer consists primarily of numerous relatively thin, basaltic lava flows with interbedded sediments extending to depths of 1,067 meters (3,500 feet) below the land surface (Irving 1993). Most of the groundwater migrates horizontally through fractured, basaltic interflow zones (broken and rubble zones) that occur at various depths. Water also migrates vertically along joints and the interfingering edges of interflow zones (Garabedian 1986). Sedimentary interbeds restrict the vertical movement of groundwater. The variability in how the aquifer stores and transmits water increases the difficulty in aquifer investigations and modeling.

The rate at which water moves through the ground depends on the hydraulic gradient (change in elevation and pressure with distance in a given direction) of the aquifer, the effective porosity (percentage of void spaces), and hydraulic conductivity (capacity of a porous media to transport water) of the soil and bedrock. Because aquifer porosity and hydraulic conductivity decrease with depth, most of the water in the aquifer moves through the upper 61 to 152 meters (200 to 500 feet) of the basalts. Estimated flow rates within the aquifer range from 1.5 to 6.1 meters (5 to 20 feet) per day (Barraclough et al. 1981).

The aquifer's ability to transmit water (transmissivity), and its ability to store water (storativity) are important physical properties of the aquifer. In general, the hydraulic characteristics of the aquifer enable the easy transmission of water, particularly in the upper portions.

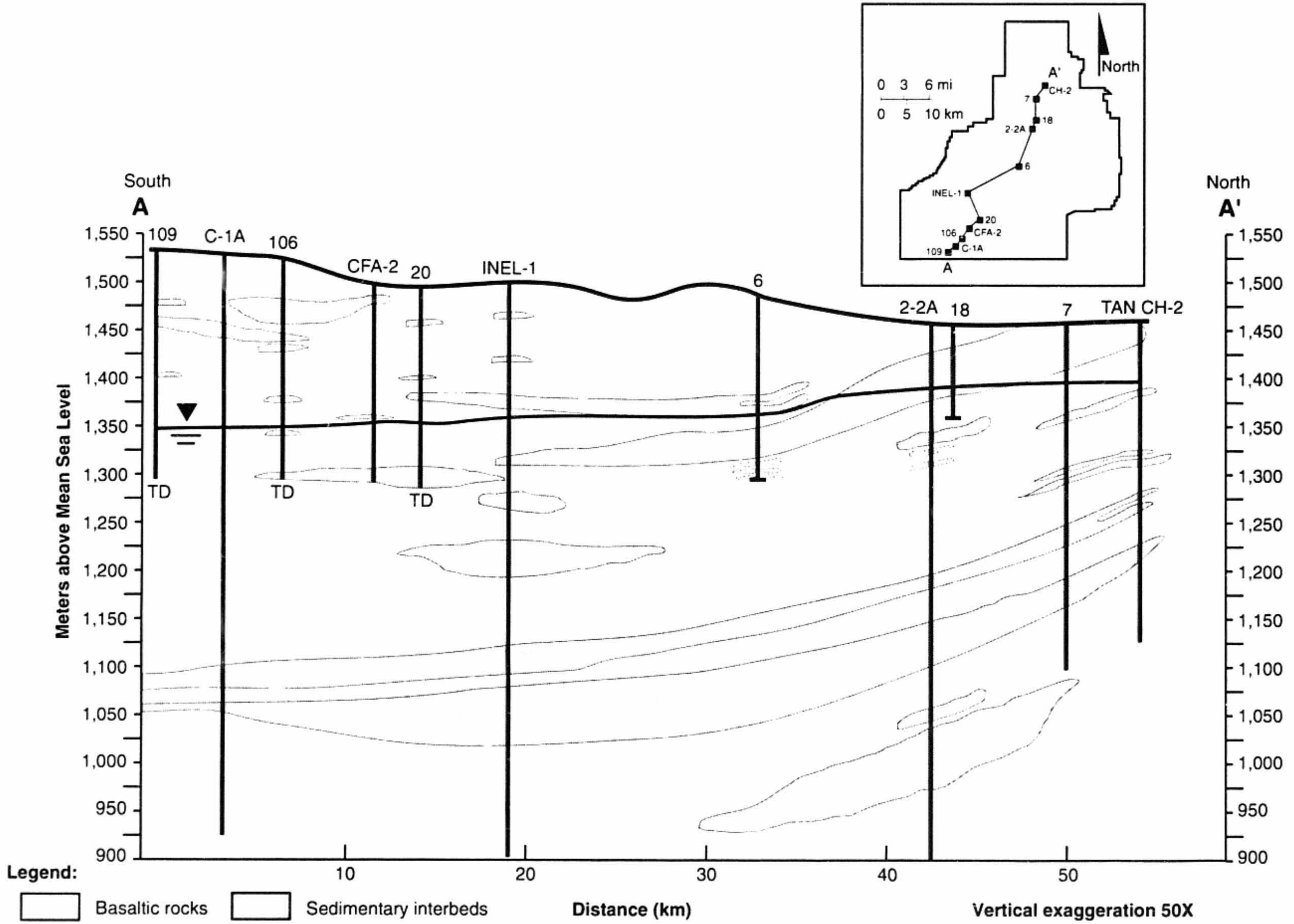

Figure 4.8-3. Hydrostratigraphy across the INEL and water table surface.

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Recharge to the aquifer originates off the site from precipitation in the mountains to the west and north. Most of the inflow to the aquifer results from the underflow of groundwater along alluvial-filled valleys adjacent to the Eastern Snake River Plain and adjacent surface-water drainages (i.e., Big and Little Lost Rivers and Birch Creek). In addition, recharge at the site is related to the amount of precipitation, particularly snowfall, for a given year (Barraclough et al. 1981).

4.8.2.3 Vadose Zone Hydrology. The vadose (unsaturated) zone extends from the land surface down to the water table. Within the vadose zone, water and air occupy openings in the geologic materials. Subsurface water in the vadose zone is referred to as vadose water. At the site this complex zone consists of surface sediments (primarily clay and silt, with some sand and gravel) and many relatively thin basaltic lava flows, with some sedimentary interbeds. Thick surficial deposits occur in the northern part of the site, which thin to the south where basalt is exposed at the surface.

The vadose zone protects the groundwater by filtering many contaminants through adsorption, buffering dissolved chemical wastes, and slowing the transport of contaminated liquids to the aquifer. The vadose zone also protects the aquifer by storing large volumes of liquid or dissolved contaminants released to the environment through spills or migration from disposal pits or ponds, allowing natural decay processes to occur.

Travel times for water through the vadose zone are important for an understanding of contaminant movement. The flow rates in the vadose zone depend directly on the extent of fracturing, the percentage of sediments versus basalt, and the moisture content of vadose zone material. Flow increases under wetter conditions and slows under dryer conditions.

4.8.2.4 Perched Water. Locally, saturated conditions that exist above the water table are called perched water. Perched water occurs when water migrates vertically and laterally from the surface until it reaches an impermeable layer (Irving 1993). As perched water spreads laterally, sometimes for hundreds of meters, it moves over the edges of the impermeable layer and continues downward. Several perched water bodies can form between the land surface and the water table.

In general, perched water bodies slow the downward migration of fluids that infiltrate into the vadose zone from the surface because the downward flow is not continuous. The occurrence of perched water at the site is related to the presence of disposal ponds or other surface-water bodies, which studies have detected at the Idaho Chemical Processing Plant, Test Reactor Area, and Test Area North. For example, a 1986 field study at the Idaho Chemical Processing Plant showed that perched

water occurs in three areas at possibly three depth zones, ranging from approximately 9 meters (30 feet) to 98 meters (322 feet) below the ground surface and extending laterally as much as 1,097 meters (3,600 feet). In general, the chemical concentrations, shape, and size of these bodies have fluctuated over time in response to the volume of water discharged to the infiltration ponds (Irving 1993).

4.8.2.5 Subsurface Water Quality. Natural water chemistry and contaminants originating at the site affect subsurface water quality. The INEL Groundwater Protection Management Program conducts monitoring programs. This program collects samples from surface water, perched water, and aquifer wells to identify contaminants and contaminant migration to and within the aquifer.

4.8.2.5.1 Natural Water Chemistry – Several factors determine the natural groundwater chemistry of the Snake River Plain Aquifer beneath the site. These factors include the weathering reactions that occur as water interacts with minerals in the aquifer and the chemical composition of (1) groundwater originating outside the site; (2) precipitation falling directly on the land surface; and (3) streams, rivers, and runoff infiltrating the aquifer (Wood and Low 1986, 1988). The chemistry of the groundwater is different, depending on the source areas. For example, groundwater from the northwest contains calcium, magnesium, and bicarbonate leached from sedimentary rocks, and groundwater from the east contains sodium, fluorine, and silicate resulting from contact with volcanic rocks (Robertson et al. 1974).

Although the natural chemical composition of groundwater beneath the site does not exceed the Environmental Protection Agency drinking water standards for any component, the natural chemistry affects the mobility of contaminants introduced into the subsurface from INEL activities. Many dissolved contaminants adsorb (or attach) to the surface of rocks and minerals in the subsurface, thereby retarding the movement of contaminants in the aquifer and inhibiting further migration of contamination. However, many naturally occurring chemicals compete with contaminants for adsorption sites on the rocks and minerals or react with contaminants to reduce their attraction to rock and mineral surfaces.

4.8.2.5.2 Groundwater Quality – Previous waste discharges to unlined ponds and deep wells have introduced radionuclides, nonradioactive metals, inorganic salts, and organic compounds to the subsurface. Table 4.8-1 summarizes the highest detected concentrations of contaminants observed in the aquifer between 1987 and 1992, concentrations near the site boundary, Environmental Protection Agency maximum contaminant levels, and DOE Derived Concentration Guides. The following

Table 4.8-1. Highest detected contaminant concentrations in groundwater at the Idaho National Engineering Laboratory (1987 to 1992).

Parameter	Highest detected recent concentration[a] (year)	Recent boundary condition (year)	Current maximum contaminant level	Derived concentration guide
Radionuclides (picocuries per liter)				
Americium-241	0.91[b] (1990)	< detection limit[c] (1988)	15[d,e]	30[f]
Cesium-137	2,050[b] (1988)	< detection limit[c] (1986)	200[g]	3,000[f]
Cobalt-60	890[b] (1987)	< detection limit[c] (1987)	100[g]	10,000[f]
Iodine-129	3.6[b] (1987)	0.00083-background[h] (1992)	1[g]	500[f]
Plutonium-238	1.28[b] (1990)	< detection limit[c] (1988)	15[d,e]	40[f]
Plutonium-239/240	1.08[b] (1990)	< detection limit[c] (1988)	15[d,e]	30[f]
Strontium-90	640[b] (1992)	< detection limit[c] (1988)	8[g,o]	1,000[f]
Tritium	48,000[b] (1988)	background[i] (1988)	20,000[g]	2,000,000[f]
Nonradioactive metals (milligrams per liter)				
Cadmium	0.0073[b] (1992)	background[c] (1988)	0.005[d]	not applicable
Chromium (total)	0.21[b] (1988)	background[c] (1988)	0.1[d]	not applicable
Lead	0.009[b] (1987)	background[c] (1987)	0.015[g,n]	not applicable
Mercury	0.0004[b] (1987)	background[c] (1987)	0.002[d]	not applicable
Inorganic salts (milligrams per liter)				
Chloride	200[b] (1991)		250[d]	not applicable
Nitrate	5.4[b] (as NO_3) (1988)	background[j] (1988)	10 (as N)[d]	not applicable
Sulfate	140[k] (1985)	background[j] (1985)	250[d]	not applicable
Organic compounds (milligrams per liter)				
Carbon tetrachloride	0.0066[b] (1993)	<detection limit[l] (1988)	0.005[d]	not applicable
Chloroform	0.95[l] (1988)	<detection limit[l] (1988)	0.1[d,m]	not applicable
1,1-dichloroethylene	0.009[b] (1989)	<detection limit[l] (1989)	0.007[d]	not applicable
Cis-1,2-dichloroethylene	3.9[b] (1992)	<detection limit[l] (1988)	0.07[d,y]	not applicable
Trans-1,2-dichloroethylene	2.6[b] (1988)	<detection limit[l] (1988)	0.1[d]	not applicable
Tetrachloroethylene	0.051[b] (1992)	<detection limit[l] (1988)	0.005[d]	not applicable
1,1,1-trichloroethane	0.012[b] (1989)	<detection limit[l] (1988)	0.2[d]	not applicable
Trichloroethylene	4.6[b] (1992)	<detection limit[l] (1989)	0.005[d]	not applicable
Vinyl chloride	0.027[l] (1989)	<detection limit[l] (1989)	0.002[d]	not applicable

a. Concentrations are generally for 1987 to 1992.
b. Golder Associates (1994).
c. Orr and Cecil (1991).
d. Maximum contaminant level values taken from EPA (1993a).
e. Maximum contaminant levels have not been established for plutonium-238, plutonium-239, plutonium-240, and americium-241. However, these radionuclides have not been detected above the established limits for gross alpha particle activity (EPA 1993a) or the proposed adjusted gross alpha activity maximum contaminant level for drinking water (FR 1991a).
f. DCGs for radionuclides taken from DOE Order 5400.5, Radiation Protection of the Public and the Environment (DOE 1990b).
g. Maximum contaminant level values taken from (CFR 1991c).
h. Mann (1994).
i. Mann and Cecil (1990).
j. Robertson et al. (1974); Edwards et al. (1990).
k. Pittman et al. (1988).
l. Mann (1990) and Liszewski and Mann (1993).
m. Value is for total trihalomethanes, which is the sum of the concentrations of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform), and trichloromethane (chloroform).
n. Lead action level.
o. Calculated value based on total body or organ dose of 4 millirem per year.

paragraphs discuss each category of contaminants and comparisons of observed concentrations to maximum contaminant levels.

Radionuclides – In general, radionuclide concentrations in the Snake River Plain Aquifer beneath the site have decreased since the mid-1980s because of changes in disposal practices, radioactive decay, adsorption of radionuclides to rocks and minerals, and dilution by natural surface water and groundwater entering the aquifer (Pittman et al. 1988; Orr and Cecil 1991; Bargelt et al. 1992). Radionuclides released and observed in the soil and groundwater include tritium, strontium-90, iodine-129, cobalt-60, cesium-137, plutonium-238, plutonium-239/240, and americium-241 (Golder Associates 1994). Most of these radionuclides have been observed at the Idaho Chemical Processing Plant and Test Reactor Area facility areas. However, radionuclides have also been observed in the Test Area North disposal well.

Concentrations of radionuclides in the aquifer have decreased over time. This decrease is attributed to reduced discharges, adsorption, radioactive decay, and improved waste management practices. As of 1992, concentrations of iodine-129, cobalt-60, tritium, strontium-90, and cesium-137 had exceeded the EPA maximum contaminant levels for radionuclides in drinking water in localized areas inside the INEL boundary. Currently, there are no individual maximum contaminant levels for plutonium-238, plutonium-239, plutonium-240, and americium-241. However, these radionuclides have not been detected above the established limits for gross radioactivity or the proposed adjusted gross alpha activity maximum contaminant level for drinking water (Golder Associates 1994; Mann et al. 1988; Orr and Cecil 1991).

Extremely low concentrations of iodine-129 and tritium have migrated outside site boundaries. In 1992, iodine-129 concentrations were well below the maximum contaminant levels in two wells approximately 6 and 13 kilometers (4 and 8 miles) south of the site boundary (Mann 1994). Tritium concentrations were much below maximum contaminant levels just south of the site boundary in 1985. By 1988 the tritium plume encompassed by the 500 picocurie per liter contour was back inside the site boundary, and its size has continued to decrease (Pittman et al. 1988; Orr and Cecil 1991; Orr et al. 1991). Cobalt-60, strontium-90, cesium-137, plutonium-238, plutonium-240/241, and americium-241 have not been detected outside the site boundaries.

Nonradioactive Metals – The INEL has released sodium, chromium, lead, and mercury on the site and into the subsurface through unlined ponds and deep wells. Of these metals, the INEL released sodium in the greatest quantity from waste treatment processes; however, sodium is not toxic and does not have an established maximum contaminant level. In 1988 chromium concentrations exceeding the maximum contaminant level were measured near the Test Reactor Area. Lead and mercury have occurred at concentrations below the maximum contaminant level near the Idaho Chemical Processing Plant (Orr and Cecil 1991).

Inorganic Salts – Human activities at the site have released chloride, sulfate, and nitrate into the subsurface. Although chloride and sulfate releases have occurred, only nitrate has exceeded maximum contaminant levels (near the Idaho Chemical Processing Plant in 1981). Disposal of nitrates to the injection well and infiltration ponds at the Idaho Chemical Processing Plant account for the elevated nitrate levels in the central portion of the site. By 1988 the levels of nitrate decreased to below the maximum contaminant level. Irrigation in the Mud Lake area might be causing these contaminants to enter the northeastern portion of the site in concentrations comparable to those in nearby irrigated areas (Orr et al. 1991; Robertson et al. 1974; Edwards et al. 1990).

Organic Compounds – Concentrations of volatile organic compounds have been detected in the aquifer beneath the site. However, many of these compounds were detected at amounts below the detection limit (0.002 milligram per liter), or two parts per billion, which is the lowest concentration at which a specific analytical method can detect a contaminant. However, concentrations of the following compounds exceeding the maximum contaminant levels have occurred in and near the Test Area North disposal well: carbon tetrachloride, chloroform, 1,2-cis-dichloroethylene, 1,1-dichloroethylene, 1,2-trans-dichloroethylene, trichloroethylene, tetrachloroethylene, and vinyl chloride (Leenheer and Bagby 1982; Mann and Knobel 1987; Mann 1990; Liszewski and Mann 1992).

4.8.2.5.3 Perched Water Quality – Wastewater discharges from INEL operations have infiltrated into the vadose zone and created most of the perched water beneath the site. Studies have detected elevated concentrations of the following contaminants in samples: tritium, cesium-137, cobalt-60, chromium, and sulfate concentrations in deep perched water near the Test Reactor Area, and strontium-90 in perched water near the Idaho Chemical Processing Plant and at Test Area North (Irving 1993; Schafer-Perini 1993). DOE has not yet measured potential concentrations of contaminants in all INEL perched water bodies. In general, the chemical concentrations, shape, and size of these bodies have fluctuated over time in response to the volume of water discharged to the infiltration ponds.

4.8.3 Water Use and Rights

The INEL does not withdraw or use surface water for site operations, nor does it discharge effluents to natural surface water. However, the three surface-water bodies at or near the site (Big and Little Lost Rivers and Birch Creek) have the following designated uses: agricultural water supply, cold-water biota, salmonid spawning, and primary and secondary contact recreation. In addition, waters in the Big Lost River and Birch Creek have been designated for domestic water supply and as special resource waters.

Groundwater use on the Snake River Plain includes irrigation, food processing and aquaculture, and domestic, rural, public, and livestock supply. Water use for the upper Snake River drainage basin and the Snake River Plain Aquifer was 16.4 billion cubic meters (4.3 trillion gallons) per year in 1985, which was more than 50 percent of the water used in Idaho and approximately 7 percent of agricultural withdrawals in the nation. Most of the water withdrawn from the Eastern Snake River Plain [1.8 billion cubic meters (0.47 trillion gallons) per year] is for agriculture. The aquifer is the source of all water used at the INEL. Site activities withdraw water at an average rate of 7.4 million cubic meters (1.9 billion gallons) per year (DOE-ID 1993e). However, the baseline annual withdrawal rate dropped to 6.5 million cubic meters (1.7 billion gallons) in 1995. The average annual withdrawal is equal to approximately 0.4 percent of the water consumed from the Eastern Snake River Plain Aquifer, or 53 percent of the maximum annual yield of a typical irrigation well. Of the quantity of water pumped from the aquifer, a substantial portion is discharged to the surface or subsurface and eventually returned to it (DOE-ID 1993d,e).

A sole-source aquifer, as designated by the Safe Drinking Water Act (SDWA 1974) is one that supplies 50 percent of the drinking water consumed in the area overlying the aquifer. Sole-source aquifer areas have no alternative source or combination of sources that could physically, legally, and economically supply all those who obtain their drinking water from the aquifer. Because groundwater supplies 100 percent of the drinking water consumed within the Eastern Snake River Plain (Gaia Northwest 1988) and an alternative drinking water source or combination of sources is not available, the Environmental Protection Agency designated the Snake River Plain Aquifer a sole-source aquifer in 1991 (FR 1991b).

DOE holds a Federal Reserved Water Right for the INEL, which permits a water pumping capacity of 2.3 cubic meters (80 cubic feet) per second and a maximum water consumption of 43 million cubic meters (11.4 billion gallons) per year for drinking, process water, and noncontact cooling. Because it is a Federal Water Right, the site's priority on water rights dates back to the establishment of the INEL.

4.9 Ecological Resources

This section describes the biotic resources — flora, fauna, threatened and endangered species, and wetlands — on the INEL site, which are typical of the Great Basin and Columbia Plateau. Because the proposed actions are most likely to affect areas near existing major facilities, this section emphasizes the biotic resources in those areas. However, because the proposed actions could affect other resources outside such areas (e.g., more mobile species like pronghorn, *Antilocapra americana*), it also describes biotic resources for the entire INEL site.

4.9.1 Flora

Vegetation on the INEL site is primarily of the shrub-steppe type and is a small fraction of the 45,000 square kilometers (111.2 million acres) of this vegetation type in the Intermountain West. The 15 vegetation associations on the INEL site range from primarily shadscale-steppe vegetation at lower altitudes through sagebrush- and grass-dominated communities to juniper woodlands along the foothills of the nearby mountains and buttes (Rope et al. 1993; Kramber et al. 1992; Anderson 1991). These associations can be grouped into six basic types: juniper woodland, grassland, shrub-steppe (which consists of "sagebrush-steppe" and "salt desert shrubs"), lava, bareground-disturbed, and wetland vegetation. Shrub-steppe vegetation, which is dominated by big sagebrush (*Artemisia tridentata*), saltbush (*Atriplex* spp.), and rabbitbrush (*Chrysothamnus* spp.) covers more than 90 percent of the INEL. Grasses include cheatgrass (*Bromus tectorum*), Indian ricegrass (*Oryzopsis hymenoides*), wheatgrasses, (*Agropyron* spp.), and squirreltail (*Sitanion hysterix*). Herbaceous plants include phlox (*Phlox* spp.), wild onion (*Allium* spp.), milkvetch (*Astragalus* spp.), Russian thistle (*Salsola kali*), and various mustards. Work being conducted by Idaho State University will provide additional information on INEL plant communities and the status of sensitive plant species.

Facility and human-disturbed (grazing not included) areas cover only about 2 percent of the INEL. Introduced annuals, including Russian thistle and cheatgrass, frequently dominate disturbed areas. These species usually are less desirable to wildlife as food and cover, and compete with more desirable perennial native species. These disturbed areas serve as a seed source, increasing the potential for the establishment of Russian thistle and cheatgrass in surrounding less-disturbed areas. Vegetation inside facility boundaries is generally disturbed or landscaped. Species richness on the INEL is comparable to that of like-sized areas with similar terrain in other parts of the Intermountain West. Plant diversity is typically lower in disturbed and modified areas.

4.9.2 Fauna

The INEL site supports animal communities characteristic of shrub-steppe vegetation and habitats. More than 270 vertebrate species occur, including 46 mammal, 204 bird, 10 reptile, 2 amphibian, and 9 fish species (Arthur et al. 1984; Reynolds et al. 1986). Common small-mammal genera include mice (*Reithrodontomys* spp. and *Peromyscus* spp.), chipmunks (*Tamias* spp.), jackrabbits (*Lepus* spp.), and cottontails (*Sylvilagus* spp.).

Songbirds and passerines commonly observed at the INEL include the American robin (*Turdus migratorius*), horned lark (*Eremophila alpestris*), black-billed magpie (*Pica pica*), sage thrasher (*Oreoscoptes montanus*), Brewer's sparrow (*Spizella breweri*), sage sparrow (*S. belli*), and western meadowlark (*Sturnella neglecta*), while resident upland gamebirds include the sage grouse (*Centrocercus urophasianus*), chukar (*Alectoris chukar*), and grev partridge (*Perdix perdix*). Common migratory bird species, which use the INEL for part of the year, include a variety of waterfowl [e.g., mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), and Canada goose (*Branta canadensis*)] and raptors [e.g., Swainson's hawk (*Buteo swainsoni*), rough-legged hawk (*B. lagopus*), and American kestrel (*Falco sparverius*)].

The most abundant big-game species that occurs on the INEL is the pronghorn, but mule deer (*Odocoileus hermonius*), moose (*Alces alces*), and elk (*Cervus elaphus*) are present in small numbers as transients. Other large mammals observed on the INEL include the coyote (*Canis latrans*), which is common across the site, and the badger (*Taxidea taxus*) and bobcat (*Felis rufus*), both of which are present across the site but are much less abundant. Fish, including kokanee salmon (*Oncorhynchos nerka*), rainbow trout (*Oncorhynchos mykiss*), and mountain whitefish (*Prosopium williamsoni*), occur on the INEL only when the Big Lost River flows onto the site (as a result of heavy rain- or snowfall in the mountains to the northwest); they are not full-time residents.

A number of researchers have studied effects of radiation exposure from contaminated areas at INEL on small mammals and birds, and have concluded that subtle sublethal effects (e.g., reduced growth rates and life expectancies) can occur in individual animals as a result of radiation exposure. However, they can attribute no population or community-level impacts to such exposures (Halford and Markham 1978; Evenson 1981; Arthur et al. 1986; Millard et. al 1990).

The monitoring of radionuclide levels outside the boundaries of the various INEL facilities and off the INEL site has detected radionuclide concentrations above background levels in individual plants

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and animals (Markham 1974; Craig et al. 1979; Markham et al. 1982; Morris 1993), but these limited data suggest that populations of exposed animals (e.g., mice and rabbits) as well as animals that feed on these exposed animals (e.g., eagles and hawks) are not at risk.

4.9.3 Threatened, Endangered, and Sensitive Species

State and Federal regulatory agency lists (Lobdell 1992, 1995), the Idaho Department of Fish and Game Conservation Data Center list, and information from site surveys provided the information to identify Federal- and state-protected, candidate, and sensitive species that potentially occur on the INEL. This information identified two Federal endangered (bald eagle, and peregrine falcon) and nine Federal Category 2 candidate (white-faced ibis, northern goshawk, ferruginous hawk, burrowing owl, long-eared myotis, small-footed myotis, pygmy rabbit, Townsend's western big-eared bat, and Idaho pointheaded grasshopper) species as animals that potentially occur on the INEL site (Table 4.9-1). Five animal species listed by the state as Species of Special Concern occur on the site. No frequent observations of the Federal- or state-listed animal species have occurred near any of the facilities where proposed actions would occur. This analysis did not identify any Federal- or state-listed plant species as potentially occurring on the INEL site. Eight plant species identified by other Federal agencies and the Idaho Native Plant Society as sensitive, rare, or unique occur on the site (Chowlewa and Henderson 1984).

4.9.4 Wetlands

The U.S. Fish and Wildlife Service National Wetlands Inventory has identified more than 130 areas inside the boundaries of the INEL that might possess some wetlands characteristics. Surveys conducted in the fall of 1992 indicate that these possible wetlands cover about 1.4 percent (33 square kilometers or 8,206 acres) of the INEL site (Hampton et al. 1993). Approximately 70 percent of these possible wetlands areas occur near the Big Lost River and its spreading areas and playas, near the Birch Creek Playa, and in an area north of and in the general vicinity of Argonne National Laboratory-West. Limited riparian (riverbank) communities with mature trees along the Big Lost River (Reynolds 1993) reflect the intermittent flow in the river (1986 and 1993 were the last two years with flow reported on the site). The remainder of the possible wetlands are scattered throughout the INEL site. In 1994, INEL began evaluating these potential wetlands to determine if they meet the Corps of Engineers definition of jurisdictional wetlands (COE 1987). Approximately 20 wetlands are near facilities and are mostly manmade (e.g., industrial waste and sewage treatment ponds, borrow pits, and gravel pits).

Table 4.9-1. Threatened and endangered species, special species of concern, and sensitive species that may be found on the INEL.

	Name	Status[a]	Comments
BIRDS	Northern goshawk *(Accipiter gentilis)*	C2, SSC, FS, BLM	The **ferruginous hawk** nests on and migrates through the INEL. This species is found throughout the INEL but is observed more frequently in juniper woodlands. The **peregrine falcon** has been observed rarely in winter, but has not been observed during other seasons. The last sighting was in 1993 (Morris 1993). It is not known to nest on the INEL and is not commonly observed near facilities (Reynolds 1993a). The **bald eagle** is a winter resident and is locally common in the far north end and on the western edge of the INEL near Howe (Reynolds 1993a). It is not known to nest on the INEL and is not commonly observed near facilities (Reynolds 1993). The **white-faced ibis**, which uses aquatic and riparian habitats, is an uncommon migrant at the INEL. The **long-billed curlew** is known to nest on the north end of the INEL near agricultural lands. The **northern goshawk** is a casual migrant through the INEL.
	Burrowing owl *(Athene cunicularia)*	C2, BLM	
	Ferruginous hawk *(Buteo regalis)*	C2, SSC, BLM	
	Swainson's hawk *(Buteo swainsoni)*	BLM	
	Great egret *(Casmerodius albus)*	SSC	
	Merlin *(Falco columbarius)*	SSC, BLM	
	Peregrine falcon *(Falco peregrinus)*	E	
	Gyrfalcon *(Falco rusticolus)*	BLM	
	Common loon *(Gavia immer)*	SSC, FS	
	Bald eagle *(Haliaeetus leucocephalus)*	E	
	Long-billed curlew *(Numenius americanus)*	SPS, BLM	
	American white pelican *(Pelecanus erythrorhynchos)*	SSC	
	White-faced ibis *(Plegadis chihi)*	C2	
MAMMALS	Merriam's shrew *(Sorex merriami)*	SPS	The **pygmy rabbit** is common on the INEL, but its distribution is patchy (Reynolds et al. 1986). Roosts and hibernation caves for **Townsend's western big-eared bat** occur on the INEL. All are over 7 kilometers (3 miles) from facilities. Brood caves might exist on the site but have not been located.
	Pygmy rabbit *(Brachylagus (Sylvilagus) idahoensis)*	C2, BLM, SSC	
	California myotis *(Myotis californicus)*	SSC	
	Fringed myotis *(Myotis thysanodes)*	SSC	
	Western pipistrelle *(Pipistrellus hesperus)*	SSC, BLM	
	Townsend's western big-eared bat *(Plecotus townsendii)*	C2, SSC, FS, BLM	
	Long-eared myotis *(Myotis evotis)*	C2	
	Small-footed myotis *(Myotis subulatus)*	CS	
PLANTS	Lemhi milkvetch *(Astragalus aquilonius)*	BLM, FS, INPS	The 8 plant species identified as sensitive, rare, or unique that are known to occur on the INEL occur primarily at a distance from INEL facilities and are uncommon on the INEL because they require unique microhabitat conditions.
	Painted milkvetch *(Astragalus ceramicus var. apus)*	3c, INPS-M	
	Winged-seed evening primrose *(Camissonia pterosperma)*	BLM, INPS-S	
	Nipple cactus *(Coryphantha missouriensis)*	INPS-M	
	Spreading gilia *(Ipomopsis (Gilia) polycladon)*	BLM, INPS-2	
	King's bladderpod *(Lesquerella kingii var. cobrensis)*	INPS-M	
	Tree-like oxytheca *(Oxytheca dendroidea)*	INPS-S	
	Sepal-tooth dodder *(Cuscuta denticulata)*	INPS-1	
INSECTS	Idaho pointheaded grasshopper *(Acrolophitus pulchellus)*	C2, BLM	Occurs just north of the INEL.

a. Key:
C2 = Federal Category 2 species.
3c = No longer considered for Federal listing.
E = Federal and state endangered species.
SSC = State species of special concern.
BLM = Bureau of Land Management monitored.
FS = U.S. Forest Service monitored.
INEL = Idaho National Engineering Laboratory.
SPS = State protected species.
INPS-S = Idaho Native Plant Society sensitive.
INPS-M = Idaho Native Plant.
INPS-1 = Idaho Native Plant Society State Priority 1.
INPS-2 = Idaho Native Plant Society State Priority 2.

4.10 Noise

The major noise sources at the INEL occur primarily in developed operational areas. These sources include facilities; equipment and machines (e.g., cooling towers, transformers, engines, pumps, boilers, steam vents, paging systems, construction equipment, and materials-handling equipment); aircraft; and bus, car, truck, and railroad traffic. At the INEL boundary, which is more than 3 kilometers (2 miles) from any facility, noise from most sources is barely distinguishable from background noise levels. Some disturbance of wildlife activities could occur at the INEL as a result of noise from operational and construction activities. The State of Idaho and the counties in which the INEL is located have not established any regulations that specify acceptable community noise levels, with the exception of prohibitions on nuisance noise.

Existing INEL-related noises of public significance are from the transportation of people and materials to and from the site and in-town facilities via buses, trucks, private vehicles, helicopters, and freight trains. During the normal workweek, most of the 4,000 to 5,000 employees who work on the site (as opposed to those working in Idaho Falls) travel daily by buses from surrounding communities (see Section 4.3). In addition, 300 to 500 private vehicles travel to the INEL site from surrounding communities each day (see Section 4.11). Noise measurements along U.S. Highway 20 about 15 meters (50 feet) from the roadway indicate that the sound level from traffic ranges from 64 to 86 decibels, A-weighted (dBA) (Abbott et al. 1990), and that the primary source is buses (71 to 81 dBA). While few people reside within 15 meters (50 feet) of the roadway, the results indicate that INEL traffic noise might be objectionable to members of the public residing near principal highways or busy bus routes. The acoustic environment along the INEL site boundary in rural areas and at nearby areas away from traffic noise is typical of a rural location, with the day-night sound level (DNL) in the range of 35 to 50 dBA (EPA 1974).

Public exposure to aircraft noise is due in part to INEL-related activities. Air cargo and business travel of INEL personnel via commercial air transport is a significant fraction of all such travel in and out of regional airports. Onsite INEL security patrol and surveillance flights do not adversely affect individuals off the site because of the INEL's remoteness. For INEL helicopter flights that originate or terminate in Idaho Falls, members of the public are exposed to the unique noises produced by these aircraft. Because the number of flights per day is limited and most flights occur during nonsleeping hours, public exposure to aircraft nuisance noise is not great.

Normally only one train per day serves the INEL, via the Scoville spur. Noise sources related to rail transport include those from diesel engines, wheel-track contact, and whistle warnings at rail crossings. Even with only one or two exposures to these sources per day, individuals residing near the railroad tracks might find the noises mildly objectionable.

4.11 Traffic and Transportation

Roads are the primary access to and from the INEL site. Commercial shipments are transported via truck and plane, some bulk materials are transported via rail, and waste is transported by road and rail. This section discusses the existing traffic volumes, transportation routes, transportation accidents, and waste and materials transportation, including baseline radiological exposures from waste and materials transportation. This section summarizes the information in Lehto (1993).

4.11.1 Roadways

4.11.1.1 Infrastructure Regional and Site Systems. Figure 4.11-1 shows the existing regional highway system. Two interstate highways serve the regional area. Interstate 15 (I-15), a north-south route that connects several cities along the Snake River, is approximately 40 kilometers (25 miles) east of the INEL site. I-86 intersects I-15 approximately 64 kilometers (40 miles) south of the INEL site, and provides a primary linkage from I-15 to points west. I-15 and US 91 are the primary access routes to the Shoshone-Bannock reservation. US 20 and US 26 are the main access routes to the southern portion of the INEL site. Idaho State Routes 22, 28, and 33 pass through the northern portion of the INEL; State Route 33 provides access to the northern INEL site facilities. Table 4.11-1 lists the baseline (1991) traffic for several of these access routes. The level of service of these segments is currently designated "free flow," which is defined as "operation of vehicles is virtually unaffected by the presence of other vehicles."

The INEL has developed an onsite road system of approximately 140 kilometers (87 miles) of paved surface, including about 29 kilometers (18 miles) of service roads that are closed to the public. Most of the roads are adequate for the current level of normal transportation activity and could handle some increased traffic volume. DOE plans to reconstruct several deteriorating INEL roads built in the 1950s that have been and will continue to be used to transport heavier-than-normal loads.

4.11.1.2 Infrastructure Idaho Falls. Approximately 4,000 DOE and contractor personnel administer and support INEL work at offices in Idaho Falls. DOE shuttle vans provide hourly transport between in-town facilities. One of the busiest intersections is Science Center Drive and Fremont Avenue, which serves Willow Creek Building, Engineering Research Office Building, INEL

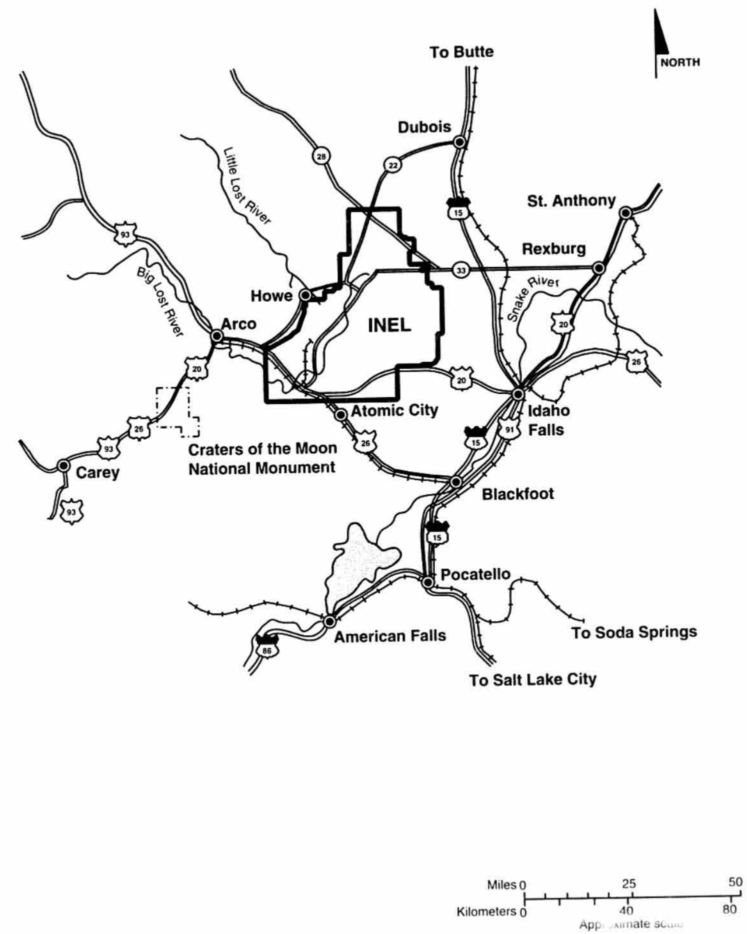


Figure 4.11-1. Transportation routes in the vicinity of the INEL.

Table 4.11-1. Baseline traffic for selected highway segments.[a]

Route	Average daily traffic	Peak hourly traffic[b]
U.S. Highway 20-Idaho Falls to INEL	2,290	344
U.S. Highway 20/26-INEL to Arco	1,500	225
U.S. Highway 26-Blackfoot to INEL	1,190	179
State Route 33 west from Mud Lake	530	80
Interstate 15-Blackfoot to Idaho Falls	9,180	1,380

a. Source: Lehto (1993).
b. Estimated as 15 percent of average daily traffic.

Electronic Technology Center, and DOE Office Buildings. This intersection is congested during peak weekday hours, but it is designed for the current traffic.

4.11.1.3 Transit Modes. Four major modes of transit use the regional highways, community streets, and INEL site roads to transport people and commodities: DOE buses and shuttle vans, DOE motor pool vehicles, commercial trucks, and personal vehicles. Table 4.11-2 summarizes the baseline miles for INEL-related traffic.

Table 4.11-2. Baseline annual vehicle miles traveled for Idaho National Engineering Laboratory-related traffic.[a]

Mode of travel and transportation	Vehicle miles traveled[b]
DOE buses	6,068,200
Other DOE vehicles	9,183,100
Commercial trucks	56,000
Personal vehicles on highways to INEL	7,500,000
TOTAL	22,807,300

a. Source: Lehto (1993).
b. To convert from miles to kilometers, multiply by 1.61.

4.11.2 Railroads

Figure 4.11-1 shows the Union Pacific Railroad lines in southeastern Idaho. Idaho Falls receives railroad freight service from Butte, Montana, to the north, and from Pocatello and Salt Lake City to the south. The Union Pacific Railroad's Blackfoot-to-Arco branch, which crosses the southern portion of the INEL, provides rail service to the site for the shipment of spent nuclear fuel and other waste, bulk commodities, and radioactive materials. This branch connects with a DOE-owned spur line at Scoville Siding, then links with developed INEL areas. Table 4.11-3 lists rail shipments for Fiscal Years 1988 through 1992.

Table 4.11-3. Loaded rail shipments to and from the Idaho National Engineering Laboratory (1988-1992).[a]

Fiscal Year	Inbound	Outbound
1988	63	44
1989	43	19
1990	34	3
1991	18	0
1992	23	0

a. Sources: DOE Shipment Mobility/Accountability Collection System database; Attachment A to Appendix D of Volume 1 of this EIS.

4.11.3 Airports and Air Traffic

Commercial airlines provide Idaho Falls with jet aircraft passenger and cargo service, as well as commuter service to both the Idaho Falls and Pocatello airports. In addition, local charter service is available in Idaho Falls, and private aircraft use the major airport and many other fields in the area. Total landings at the Idaho Falls airport for 1991 and 1992 were 5,367 and 5,598, respectively. The Idaho Falls and Pocatello airports collectively record nearly 7,500 landings annually.

Non-DOE air traffic over the INEL site is limited to altitudes greater than 305 meters (1,000 feet) over buildings and populated areas, and non-DOE aircraft are not permitted to use the site. The primary air traffic at the INEL site is DOE helicopters, which are used for security and emergency purposes. These helicopters have specific operations stations and duties.

4.11.4 Accidents

From 1987 through 1992, the average motor vehicle accident rate was 0.94 accident per million kilometers (1.5 accidents per million miles) for INEL vehicles, which compares with an accident rate of 1.5 accidents per million kilometers (2.4 accidents per million miles) for all DOE complex vehicles and 8 accidents per million kilometers (12.8 accidents per million miles) nationwide for all motor vehicles (Lehto 1993). There are no recorded rail or air accidents associated with the INEL and, to date, no fatal air traffic accidents have involved flights through either the Idaho Falls or Pocatello airports.

4.11.5 Transportation of Waste, Materials, and Spent Nuclear Fuel

Hazardous, radioactive, industrial commercial, and recyclable wastes are transported on the INEL site. Federal and State regulations and requirements govern the transportation of hazardous and radioactive materials (Lehto 1993). Hazardous materials include commercial chemical products and hazardous wastes that are nonradioactive; they are regulated and controlled based on their chemical toxicity. Onsite spent nuclear fuel comes from Argonne National Laboratory - West, the Naval Reactors Facility, and the Advanced Test Reactor; it is transported by truck to various onsite storage and research and development facilities.

This assessment used six years of data (1987 through 1992) to establish a baseline of radiological doses from incident-free, onsite total nonnaval spent nuclear fuel transportation at the INEL. Table 4.11-4 lists the results in terms of cumulative doses (1995-2035) and health effects. These doses do not include onsite naval shipments, which are assessed in Attachment A to Appendix D of Volume 1 of this EIS. The baseline includes no offsite shipments, which are addressed in Appendixes D and I.

Table 4.11-4. Cumulative doses and cancer fatalities from incident-free onsite shipments of nonnaval spent nuclear fuel at the Idaho National Engineering Laboratory for 1995 through 2035.[a,b]

	Estimated collective dose (person-rem)	Estimated cancer fatalities
Occupational	3.4	0.0014
General population	0.087	0.000044

a. Source: Maheras (1993).
b. Onsite naval shipment doses are addressed in Attachment A to Appendix D of Volume 1 of this EIS.

4.12 Occupational and Public Health and Safety

4.12.1 Radiological Health and Safety

DOE Order 5480.11, "Radiation Protection for Occupational Workers" (DOE 1992b), limits the radiation dose that INEL workers can receive to 5 rem per year; administrative controls further limit a worker dose to 2 rem per year, except under unusual circumstances. In addition, DOE has established a comprehensive program, known as ALARA (As Low As Reasonably Achievable), to ensure the reduction of occupational doses to the extent practicable.

The largest fraction of the occupational dose received by INEL workers is from external radiation. Internal radiation doses constitute a small fraction of the occupational dose. Personnel who could receive annual external radiation exposures with measured doses greater than 0.1 rem receive a thermoluminescent dosimeter that they must wear at all times during work on the site. DOE used recorded doses for 1987 to 1991 as a baseline for routine site operations for this EIS. During this period, the INEL monitored about 6,000 workers annually for radiation exposure. About 32 percent of those individuals received measurable radiation doses. Monitoring reports indicate that, from 1987 to 1991, 20 individuals (most of whom were maintenance and construction workers employed by M-K Ferguson at the Idaho Chemical Processing Plant) received annual doses larger than 2 rem (4 individuals in 1987, 1 in 1989, and 15 in 1990).

From 1987 to 1991, the average occupational dose to individuals who had received measurable doses was 0.156 rem per year, resulting in an average collective dose (the number of monitored workers receiving measurable doses was about 32 percent or 1,920) of about 300 person-rem. The resulting number of expected excess latent cancer fatalities would be less than 1 for each year of operation.

This analysis based the doses to the maximally exposed individual and offsite population on baseline radioactive concentrations associated with normal operations. The baseline dose to the maximally exposed individual is 5.6×10^{-2} millirem, which corresponds to a latent fatal cancer probability of 2.8×10^{-8}. The baseline population dose is 7.0×10^{-2} person-rem which, corresponds to a latent fatal cancer incidence of less than 1 (4×10^{-5}) annually and less than 1 (1×10^{-3}) over 40 years.

4.12.2 Nonradiological Exposure and Health Effects

DOE used the air quality data in Table 4.7-2 to evaluate health impacts associated with potential exposure to two compound classes: criteria pollutant and toxic. This analysis has based health effects on air emissions only, and not water pathways, because none of the alternatives would involve the discharge of pollutants to surface waters or the subsurface. Table 4.7-2 lists 5 criteria pollutant and 26 toxic compounds. The classification of two of the toxic compounds (benzene and formaldehyde) as carcinogens was consistent with EPA designations published in the Integrated Risk Information System (IRIS) data base (DOE 1991b). However, this data base does not include sufficient data to perform a quantitative inhalation cancer risk assessment.

To obtain a hazard index, this analysis evaluated toxic and criteria pollutant compound health effects by adding hazard quotients for each compound. The EPA Risk Assessment Guidance for Superfund (EPA 1989) describes this approach. The hazard quotient is the ratio of compound concentration or dose to a Reference Concentration (RfC) or Dose (RfD). For compounds without listed Reference Concentration or Dose values, the analysis used appropriate State of Idaho standards. The use of the noncancer hazard index assumes a level of exposure (standard) below which adverse health effects would be unlikely. The hazard index is not a statistical probability; therefore, it cannot be interpreted as such.

This analysis based toxic and criteria pollutant compound hazard index values for the maximally exposed individual on the maximum concentrations for the compounds at the INEL site boundary, public access roads inside the INEL site boundary, and the Craters of the Moon Wilderness Area. Because the hazard index for criteria pollutants is less than 1, no adverse health effects would be likely from routine operations for either workers or the maximally exposed individual. Because the hazard index for toxic pollutants exceeds 1, the potential for carcinogenic health risks could exist. However, varying spacial and temporal distributions of the concentrations of individual air pollutants make it unlikely that any individual would be exposed to all the pollutants all the time. Since individual hazard indices for the toxic compounds are less than 1, adverse health effects are not expected.

4.12.3 Occupational Health and Safety

Total injury and illness incidence rates at the INEL varied from an annual average of 1.8 to 4.9 per 200,000 work hours from 1987 to 1991. During this time, total lost workday cases ranged from a low of 1 per 200,000 work hours in 1988 and 1989 to a high of 2.6 per 200,000 work hours in

1991. The rates appear higher for 1991 because of a 1990 change in reporting requirements for injuries and illnesses. INEL rates for 1987 to 1989 are below overall DOE rates (2.9 total injury and illness incidence and 1.4 total lost workday cases per 200,000 work hours) and Bureau of Labor Statistics rates (8.5 total injury and illness incidence and 4.0 total lost workday cases per 200,000 work hours). For 1990 and 1991, INEL rates are slightly above overall DOE rates, but below Bureau of Labor Statistics rate.

There were 1,337 total recordable injury and illness cases at the INEL from 1987 to 1991, for an average of 8,385 employees working 79,654,000 hours. Of these cases, 114 (8.5 percent) were occupational illnesses, of which 48 percent were repeated trauma disorders and 30 percent were classified as skin diseases or disorders. One fatality occurred at the INEL between 1987 and 1991 when an employee was struck and killed by a forklift.

4.13 Idaho National Engineering Laboratory Services

This section discusses water, electricity, fuel capacities and consumption, wastewater disposal, and security and emergency protection at INEL facilities.

4.13.1 Water Consumption

A system of about 30 wells, with pumps and storage tanks, provides the water supply for the INEL site. Because of the distance between site facility areas, the water supply system for each facility is independent. The site uses no natural surface water. The City of Idaho Falls water supply system, which includes about 16 wells, provides water to DOE and contractor facilities in the city.

A Water Rights Agreement between DOE and the State of Idaho regulates groundwater use at the INEL site. Under this agreement, INEL has claim to 2,300 liters per second (36,000 gallons per minute) of groundwater, not to exceed 43 billion liters (11 billion gallons) per year (Teel 1993). DOE has not measured the total pumping rate from the aquifer, which would depend on the number of pumps operating. There is a slight possibility that the site could exceed the regulated pumping rate for very short periods, such as during recovery from an extended power outage when many pumps would run to refill depleted storage tanks.

The average INEL site water consumption from 1987 through 1991 was 7.4 billion liters (1.9 billion gallons) per year, based on the cumulative volumes of water withdrawn from the wells (Teel 1993). The projected baseline usage for 1995 will be about 6.5 billion liters (1.7 billion gallons). The estimated average water consumption of Idaho Falls facilities is 300 million liters (80 million gallons) per year.

4.13.2 Electricity Consumption

The Antelope substation supplies commercial electric power to the INEL site through two feeders to the Federally owned Scoville substation. The Scoville substation supplies electric power directly to the INEL electric power distribution system (Teel 1993). The contract with Idaho Power Company to supply electric power to the INEL site provides "up to 45,000 kilowatts monthly" at 13.8 kilovolts (IPC/DOE 1986). Hydroelectric generators along the Snake River in southern Idaho and the Bridger and Valmy coal-fired thermal electric generation plants in southwestern Wyoming and northern

Nevada, respectively, generate the electric power supplied by Idaho Power. The Experimental Breeder Reactor-II can also provide approximately 12 to 15 megavolt-amperes of capacity for the electric power loop (Teel 1993).

The rated capacity of the INEL site power transmission loop line is 124 megavolt-amperes. The peak demand on the system from 1990 through 1993 was about 40 megavolt-amperes, and the average usage was slightly less than 217,000 megawatt-hours per year (Teel 1993). This usage rate should decrease by about 4 percent by 1995.

The INEL facilities in Idaho Falls receive electric power from the City of Idaho Falls, which operates four hydroelectric power generation plants on the Snake River along with substation and distribution facilities. The Bonneville Power Administration, which operates hydroelectric plants on the Columbia River system, supplies supplemental power to the City of Idaho Falls. In 1993, Idaho Falls facilities used 31,500 megawatt-hours of electricity (Teel 1993).

4.13.3 Fuel Consumption

Fuels consumed at the INEL site include several liquid petroleum fuels, coal, and propane. All fuels are transported to the site for storage and use. Natural gas is the only reported fuel consumed at the INEL Idaho Falls facilities; the Intermountain Gas Company provides this fuel through a system of underground lines (Teel 1993).

The average annual fuel consumption at the INEL site from 1990 through 1993 was as follows: fuel oil, 10,578,000 liters (2,795,000 gallons); diesel fuel, 5,690,000 liters (1,500,000 gallons); and propane gas, 568,000 liters (150,000 gallons). The INEL also uses about 8,200 metric tons (9,000 tons) of coal. Fuel storage is provided at each facility and inventories are restocked as necessary. No fossil fuel shortage has ever occurred at the INEL site (Teel 1993).

4.13.4 Wastewater Disposal

Sanitary wastewater systems at the smaller onsite facility areas consist primarily of septic tanks and drain fields. The larger areas, such as Central Facilities Area, Idaho Chemical Processing Plant, and Test Reactor Area, have wastewater treatment facilities. The City of Idaho Falls wastewater treatment system serves the Idaho Falls facilities (Teel 1993).

The average annual wastewater discharge volume at the INEL site from 1989 through 1991 was 537 million liters (142 million gallons). The wastewater from DOE and contractor-operated facilities in Idaho Falls is not metered but is estimated to be 300 million liters (80 million gallons) per year. The primary causes of the difference between water pumped and estimated wastewater discharge are evaporation from ponds and cooling towers, irrigation of landscaped areas, and discharge of unmetered wastewater (Teel 1993). Some industrial wastewater, such as steam condensate, is also discharged to evaporation ponds and injection wells.

4.13.5 Security and Emergency Protection

This section describes the fire protection and prevention, security, and emergency preparedness resources for the INEL site and the surrounding areas. This discussion includes the INEL Fire Department, DOE and INEL Emergency Preparedness, and DOE and INEL Security. DOE established an Emergency Management System that incorporates all applicable requirements for emergency planning, preparedness, and response at the INEL. Each INEL facility must prepare an Emergency Plan that contains detailed contingency plans and emergency procedures.

4.13.5.1 DOE Fire Department. The contractor-operated Fire Department staffs and operates three fire stations on the INEL that support the entire site. Each station has the equipment and expertise to respond to explosions, fires, spills, and medical emergencies. These stations are on the north end at Test Area North, at Argonne National Laboratory-West, and at the Central Facilities Area. Each station has a minimum of one engine company capable of supporting any fire emergency in its assigned area. The Fire Department has a staff of 44 firefighters and 11 support personnel and operates with a minimum critical staff of 7 firefighters at any time. In addition to providing firefighting services, the Fire Department provides the INEL ambulance, emergency medical technician (EMT), and hazardous material response services. The Fire Department has mutual aid agreements with other firefighting organizations, such as the Bureau of Land Management and the Cities of Idaho Falls, Blackfoot, and Arco. Through these agreements, the Idaho Falls Fire Department serves DOE facilities in the City of Idaho Falls.

4.13.5.2 DOE and INEL Emergency Preparedness. Each DOE INEL contractor administers and staffs its own emergency preparedness program under the direction and supervision of DOE. All contractor programs for emergency control and response are compatible. The Warning Communication Center is in the DOE Headquarters building and staffed by the INEL prime contractor with DOE oversight; it is the communication and overall control center for support to onscene

commanders in charge of an emergency response. The DOE emergency preparedness system includes mutual aid agreements with all regional county and major city fire departments, police, and medical facilities. Through the agreements, the Idaho Falls emergency preparedness organizations serve DOE facilities in the City of Idaho Falls.

4.13.5.3 DOE and INEL Security. DOE has oversight responsibility for safeguards and security at the INEL. The security program has three categories: security operations, personnel security, and safeguards. The security operations division provides asset protection (classified matter, special nuclear material, facilities, and personnel) and technical security (computer and information). Under this category, DOE administers the INEL protective force, which is supplied by contract. The personnel security staff processes personnel security clearances. The safeguards department is responsible for the management and accountability of special nuclear materials. The INEL protective force, consisting of 200 armed guards and 350 support personnel, provides the onsite personnel who administer the programs. Each INEL contractor has a safeguards and security staff, divided in a similar manner, to manage the security associated with its facilities. Contractor safeguards and security staffs range from about 5 to 60 persons, depending on the size and complexity of the associated facilities. Each staff works with the INEL protective forces.

4.14 Materials and Waste Management

This section summarizes the management of materials and wastes (high-level, transuranic, mixed low-level, low-level, hazardous, industrial and commercial solid wastes and hazardous materials) at the INEL and Idaho Falls facilities, and presents an overview of the current status of the various waste types generated, stored, and disposed at the INEL.

The total amount of waste generated and disposed has been reduced through waste minimization and treatment. The INEL attains waste minimization by reducing or eliminating waste generation, by recycling, and by reducing the volume, toxicity, or mobility of waste before storage or disposal. In addition, the site has achieved volume reduction of radioactive wastes through more intensive surveying, waste segregation, and use of administrative and engineering controls.

The quantitative data presented in this section are from Volume 2 of this EIS, unless otherwise noted.

4.14.1 High-Level Waste

At present, about 11,900 cubic meters (4,970 cubic yards calcine solid and 2,140,000 gallons liquid) of high-level waste are in storage at the INEL Idaho Chemical Processing Plant (see Figure 2-1 for locations of major waste management facilities). This facility blends liquid waste, consisting of aluminum and zirconium wastes from past spent nuclear fuel reprocessing, and sodium-bearing wastes, and processes them through calcination to produce a granular calcine solid. Because of the termination of reprocessing, the site no longer generates liquid high-level waste, with the exception of high-level waste residues. Liquid high-level wastes generated by prior reprocessing activities are solidified at the site. At present, the site generates liquid waste that is not directly the result of reprocessing. The site manages this liquid as high-level waste. The site will calcine the liquid high-level waste that does not contain sodium, and as much sodium-bearing high-level waste as practicable by January 1, 1998, in accordance with the *Amended Order Modifying Order of June 28, 1993*, United States District Court for the District of Idaho, December 22, 1993. The projected 1995 baseline for high-level waste generation is 750 cubic meters (980 cubic yards) annually (EG&G 1993).

4.14.2 Transuranic Waste

About 65,000 cubic meters (85,000 cubic yards) of transuranic and alpha-contaminated low-level wastes are retrievably stored and 62,000 cubic meters (81,000 cubic yards) of transuranic waste (Morton and Hendrickson 1995) have been buried at the Radioactive Waste Management Complex at the INEL. At present, no facilities can dispose of transuranic waste; however, DOE ultimately intends to retrieve, repackage, certify, and ship stored transuranic wastes at the INEL to a potential Federal repository for final disposition. DOE has not determined the disposition of alpha-contaminated low-level waste and buried waste. Since the October 1988 ban by the State of Idaho prohibiting shipments of transuranic waste to the INEL, DOE has shipped only minor amounts of transuranic waste generated on the site to the INEL Radioactive Waste Management Complex for interim storage. At present, there are no treatment facilities for transuranic wastes at the INEL. The projected 1995 baseline for transuranic waste generation is 6 cubic meters (8 cubic yards) annually (EG&G 1993).

4.14.3 Mixed Low-Level Waste

At present, DOE accepts only mixed low-level waste generated at the INEL for treatment and disposal at the INEL. DOE stores mixed low-level waste generated at the INEL at interim storage facilities until treatment systems become available or operational. A total of 1,800 cubic meters (2,400 cubic yards) of mixed low-level waste interim storage capacity is available at the INEL. Current mixed low-level waste interim storage is approximately 1,100 cubic meters (1,400 cubic yards). Treatment technologies exist for much of the mixed low-level waste generated at the INEL, and waste minimization eliminates potential sources of mixed low-level waste before generation. The projected 1995 baseline for mixed low-level waste is 525 cubic meters (687 cubic yards) annually (EG&G 1993).

4.14.4 Low-Level Waste

Through 1991, DOE disposed of 145,000 cubic meters (190,000 cubic yards) of low-level waste at the Radioactive Waste Management Complex. In 1991, the total available low-level waste disposal capacity at the complex was 37,000 cubic meters (48,000 cubic yards). DOE has curtailed low-level waste treatment since 1991 while waiting for updated safety documentation and an environmental impact assessment for the Waste Experimental Reduction Facility. The INEL stores low-level waste awaiting treatment on asphalt or concrete pads at the Waste Experimental Reduction Facility and in radioactive waste storage containers at the generating facilities. The projected 1995 baseline for low-level waste generation is 4,270 cubic meters (5,585 cubic yards) annually (EG&G 1993).

4.14.5 Hazardous Waste

DOE collects hazardous waste generated at the INEL and stores it temporarily at the Hazardous Waste Storage Facility before shipping it off the site. The Hazardous Waste Storage Facility has adequate storage capacity [approximately 64 cubic meters (84 cubic yards)] to manage the quantities of hazardous waste generated at the INEL. The site recycles, reuses, or reprocesses such waste if possible, and might replace some hazardous substances with nonhazardous substances.

4.14.6 Industrial/Commercial Solid Waste

DOE disposes of the industrial and commercial solid waste generated at the site in the INEL Landfill Complex at the Central Facilities Area. The Landfill Complex has approximately 910,000 square meters (225 acres) of land available for solid waste disposal, including the remaining area at Landfill III, which is currently in use. The estimated capacity of the INEL Landfill Complex will be sufficient to dispose of INEL waste for 30 to 50 years; however, capacity of the current excavations will be filled by 1998. DOE has proposed expanding the excavation. Volume 2 of this EIS describes the landfill expansion project. The industrial and commercial solid waste landfill currently in use is in a 48,000-square-meter (12-acre) gravel pit area north of Disposal Area II. DOE does not expect to store solid waste intended for disposal. Waste segregation occurs at each INEL facility so recyclable materials do not enter the solid waste stream. The average annual volume of waste disposed at the Central Facilities Area landfill from 1988 through 1992 was approximately 52,000 cubic meters (68,000 cubic yards) (also the projected 1995 baseline) (EG&G 1993).

4.14.7 Hazardous Materials

The INEL 1993 chemical inventory lists 774 hazardous chemicals. The number and the total weight of hazardous chemicals used on the site and at individual facilities change daily in response to use. The annual Superfund Amendments and Reauthorization Act reports for the INEL facilities include year-to-year inventories.

5. ENVIRONMENTAL CONSEQUENCES

5.1 Overview

This chapter discusses the potential environmental consequences for each spent nuclear fuel management alternative described in Chapter 3. The U.S. Department of Energy (DOE) used the environmental consequence analyses of nonnaval spent nuclear fuel management from Volume 2 as input for this chapter; however, DOE made necessary adjustments to accommodate the differences between Volume 1 and Volume 2 alternatives. In addition, DOE adjusted the 10-year planning horizon for Volume 2 alternatives to 40 years for Volume 1.

As described in Chapter 1, this chapter analyzes only nonnaval DOE actions; however, Section 5.16, "Cumulative Impacts and Impacts from Connected or Similar Actions," includes impacts from the Naval Nuclear Propulsion Program and nonnaval DOE impacts that are cumulative. The Appendix B restriction of analysis to nonnaval actions results in Alternative 2 (options 2a, 2b, and 2c) becoming a single alternative.

Chapter 5 addresses potential impacts from construction and normal operations for each element of the affected environment described in Chapter 4. In addition, it provides potential consequences from accidents and several types of summary information. In cases where the consequence analysis does not result in a distinction among the alternatives, this chapter describes the consequences without division by alternative to avoid needless repetition. Tables 3-4 through 3-6 in Section 3.2 summarize and compare the potential impacts associated with each alternative.

5.2 Land Use

Alternatives 1, 2, 4b(2), and 5a [No Action, Decentralization, Regionalization by Geography (Elsewhere), and Centralization at other DOE sites] would have the least impact on land use, affecting 0.8 acre (0.003 square kilometer); Alternatives 4b(1) [Regionalization by Geography (INEL)] and 5b (Centralization at the INEL) would result in the greatest changes, impacting nearly 31 acres (0.12 square kilometer).

Overall environmental impacts on land use by any of the alternatives would be small because DOE would build new facilities in developed areas that it has already dedicated to industrial use and that previous activities have disturbed. Under all the alternatives, proposed activities would be consistent with the existing land use plans discussed in Section 4.2 and would be similar to uses in existing developed areas on the site. None of the proposed activities would involve land outside the INEL boundaries, and no effects on surrounding land uses or local land use plans should occur.

No onsite land use restrictions due to Native American treaty rights would exist for any of the alternatives described in this EIS. Potential impacts on Native American and other cultural resources are discussed in Section 5.4 (Cultural Resources) and in Appendix L (Environmental Justice).

5.3 Socioeconomics

This section describes the potential effects of the spent nuclear fuel alternatives on the socioeconomic resources of the region of influence described in Section 4.3. Tables 5.3-1 and 5.3-2 list proposed changes in the INEL-related workforce and population. Figure 5.3-1 shows these proposed changes.

5.3.1 Methodology

This section addresses socioeconomic impacts in terms of both direct and secondary employment and population effects. Direct effects are changes in INEL employment that DOE expects to occur under each alternative and include construction and operations phase impacts. Secondary effects include indirect and induced impacts. Indirect effects are impacts to regional businesses and employment resulting from changes in DOE regional purchases or nonpayroll expenditures. Induced effects are impacts to regional businesses and employment that result from changes in payroll spending by affected INEL employees. The total economic impact to the region is the sum of direct and secondary effects.

The bases for the estimated direct impacts in this section are project summary data that DOE developed in cooperation with INEL contractors. Employment impacts represent actual changes in INEL staffing; they do not include changes in staffing due to a reassignment of the existing INEL workforce. The projected decline in baseline INEL activity is not part of any alternative and therefore, a comprehensive analysis of potential impacts was not included. Projected declines in baseline site employment are presented in Figure 5.3-1 in order to provide the reader with a framework for evaluating potential employment and population impacts. This assessment used RIMS II to estimate total employment impacts with multipliers that the U.S. Bureau of Economic Analysis developed specifically for the INEL region of influence. A comprehensive discussion of the methodology is provided in Appendix F-1 of Volume 2. Cumulative impacts on socioeconomic resources in the region are discussed in Section 5.16.

Table 5.3-1. Estimated changes in employment and population for Alternatives 3, 4a, 4b(1) and 5b, 1995 - 2004.[a]

Factor	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct employment	0	0	0	0	250	250	375	375	375	375
Secondary employment	0	0	0	0	352	352	528	528	528	528
Total employment change	0	0	0	0	602	602	903	903	903	903
Change in ROI[b] labor force (%)	0.0	0.0	0.0	0.0	0.5	0.5	0.8	0.8	0.8	0.7
Change in ROI employment (%)	0.0	0.0	0.0	0.0	0.6	0.6	0.8	0.8	0.8	0.8
Population change	0	0	0	0	2,027	2,027	3,040	3,040	3,040	3,040
Change in ROI population (%)	0.0	0.0	0.0	0.0	0.8	0.8	1.1	1.1	1.1	1.1

a. Sources: Johnson (1995); USBEA (1993); USBC (1992).
b. ROI = region of influence.

Table 5.3-2. Estimated changes in employment and population for Alternatives 4b(2) and 5a, 1995 - 2004.

Factor	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Direct employment	50	50	0	0	0	0	0	0	0	0
Secondary employment	70	70	0	0	0	0	0	0	0	0
Total employment change	120	120	0	0	0	0	0	0	0	0
Change in ROI[a] labor force (%)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change in ROI employment (%)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Population change	405	405	0	0	0	0	0	0	0	0
Change in ROI population (%)	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a. Sources: Johnson (1995); USBEA (1993); USBC (1992).
b. ROI = region of influence.

5.3.2 Alternatives 1 and 2 - No Action and Decentralization

Activities associated with Alternatives 1 and 2 would not result in any additional construction or operations jobs at the INEL; therefore, implementation of either of these alternatives would have no impact on socioeconomic resources in the region of influence.

5.3.3 Alternatives 3, 4a, 4b(1), and 5b - 1992/1993 Planning Basis, Regionalization by Fuel Type, Regionalization by Geography (INEL), and Centralization at the INEL

5.3.3.1 Construction. As listed in Table 5.3-1, construction employment under these alternatives would peak during the period from 2001 to 2004 with approximately 375 additional direct jobs per year. When added to the estimated 528 indirect jobs, the total employment impact in the region would be an addition of approximately 903 jobs. Employment would decline to zero by 2008.

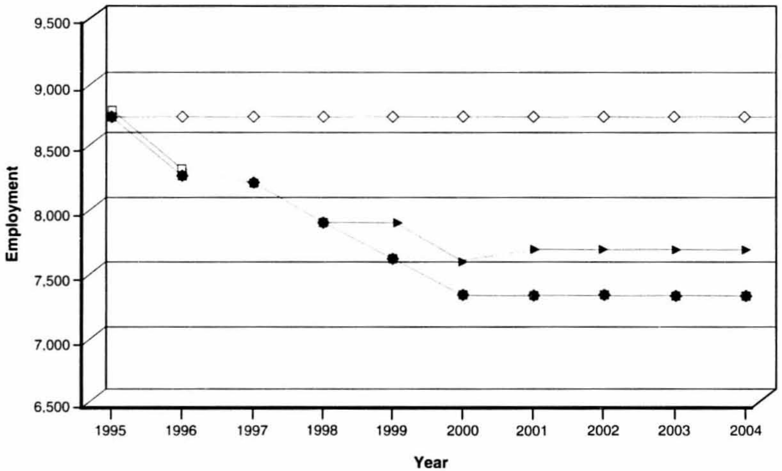
Based on historic data, approximately 97 percent of the new employees who would fill these jobs would live in the seven-county region of influence. As listed in Table 5.3-1, if all new jobs (903) were filled by in-migrants to the region, there would be a 0.8-percent increase in the regional labor force and in regional employment during the peak years. These changes would be minimal and would have no adverse impacts on socioeconomic resources in the region. In fact, although the implementation of any of these alternatives would result in an increase over projected employment levels, as shown in Figure 5.3-1, there would be an overall decline in employment from projected 1995 levels.

Assuming each new employee represented one household and 3.47 persons per household, there would be a corresponding increase in regional population levels of 1.1 percent (approximately 3,000 people). Given this minor change in population, DOE expects potential impacts on the demand for community resources and services such as housing, schools, police, health care, and fire protection to be negligible.

5.3.3.2 Operations. Activities associated with Alternatives 3, 4a, 4b(1), and 5b would not require any additional operations jobs at the INEL. Therefore, the implementation of either of these alternatives would have no impact on socioeconomic resources in the region of influence.

5.3.4 Alternatives 4b(2) and 5a - Regionalization by Geography (Elsewhere) and Centralization at Other DOE Sites

5.3.4.1 Construction. As listed in Table 5.3-2, construction employment under these alternatives would peak during the period from 1995 to 1996 with approximately 50 additional direct jobs per year. When added to the estimated 70 indirect jobs, the total employment impact in the region would be approximately 120 jobs. Employment after 1996 would drop to zero.



Legend:

- ■ Projected site employment as of January 9, 1995.
- □ Alternatives 4b(2) and 5a
- ◆ Alternatives 1 and 2[a]
- ◇ 1995 employment level
- ► Alternatives 3, 4b(1), and 5b

a. Alternatives 1 and 2 are the same as the projected site employment.

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Figure 5.3-1. INEL employment by SNF alternative relative to site employment projections.

Based on historic data, approximately 97 percent of the new employees who would fill these jobs would live in the seven-county region of influence. As listed in Table 5.3-2, if all new jobs (120) were filled by in-migrants to the region, there would be a 0.1-percent increase in the regional labor force and in regional employment levels during the peak years. These changes would be minimal and would have no adverse impacts on socioeconomic resources in the region. In fact, although the implementation of any of these alternatives would be an increase over projected employment levels from 1995 to 1996, as shown in Figure 5.3-1, there would be an overall decline in employment from projected 1995 levels.

Assuming each new employee represented one household and 3.47 persons per household, there would be a corresponding increase in regional population levels of 0.2 percent (approximately 400 people). Given this minor change in population, DOE expects potential impacts on the demand for community resources and services such as housing, schools, police, health care, and fire protection to be negligible.

5.3.4.2 Operations. Activities associated with Alternatives 4b(2) and 5a would not result in any additional operations jobs at the INEL. Therefore, the implementation of either of these alternatives would have no impact on socioeconomic resources in the region of influence.

5.4 Cultural Resources

This section summarizes the potential impacts of spent nuclear fuel management activities on cultural resources at the INEL site.

This assessment evaluated both direct and indirect impacts due to the proposed alternatives. At the INEL, direct impacts to archaeological resources usually would be those associated with ground disturbance from construction activities. Direct impacts to existing historic structures could result from demolition, modification, deterioration, isolation from or alteration of the character of the property's setting; or introduction of visual, audible, or atmospheric elements out of character or that alter the property's setting. In addition, indirect impacts to archaeological resources could occur due to an overall increase in activity at the INEL, which could bring a larger workforce closer to significant sites. Direct impacts to traditional resources could occur through land disturbance, vandalism, or changes to the environmental settings of traditional use and sacred areas. Impacts could result from pollution, noise, and contamination that could affect the traditional hunting and gathering areas or the visual or audible settings of sacred areas.

The potential for adverse impacts on cultural resources would be the least under Alternatives 1, 2, 4b(2), and 5a, which would disturb approximately 0.8 acres (0.003 square kilometer). Impacts would be minor because surveys of the area to be disturbed found no eligible cultural resources (Reed et al. 1986; DOE 1993a).

The potential for adverse impacts on cultural resources would be similar under Alternatives 3, 4a, 4b(1), and 5b with the greatest potential under Alternatives 4b(1) and 5b [Regionalization by Geography (INEL) and Centralization at the INEL], which would involve the disturbance of nearly 31 acres (0.12 square kilometer). Again, impacts would be minimal because surveys of the previously disturbed area found no eligible cultural resources (Reed et al. 1986). Under these alternatives, proposed modifications at the Idaho Chemical Processing Plant facilities could adversely affect historically significant structures and could require consultation with the Idaho State Historic Preservation Office (Braun et al. 1993).

The Shoshone-Bannock Tribes are also concerned with the potential impact to important Native American resources from changes in the visual setting, noise, air quality, or water quality. Because activities associated with spent nuclear fuel management would take place within existing facility areas currently engaged in similar activities, DOE does not expect any impacts to important Native

American resources from alteration of the visual setting or noise associated with implementation of any of the alternatives. There could be temporary, minor impacts on air quality from fugitive dust associated with construction activities. Emissions of radionuclides to the air under normal operations would be minor and would be well below applicable standards and guidelines. Under normal operating conditions, radioactive discharges to the soil or directly to the aquifer would not occur.

DOE would minimize the potential for direct and indirect adverse impacts on traditional use resources from pollution, noise, and contamination through compliance with applicable local, state, and Federal laws and regulations. Impact avoidance and other mitigation measures for cultural resources are described in Section 5.20.2.

5.5 Aesthetic and Scenic Resources

None of the alternatives for spent nuclear fuel management at the INEL would have adverse consequences on scenic resources or aesthetics because DOE would confine the proposed projects to developed areas. Although the construction of the proposed facilities would produce fugitive dust that could temporarily affect visibility, the INEL would follow standard construction practices to minimize both erosion and dust generation. Facility operations under each alternative would not produce emissions to the atmosphere that would impact visibility.

5.6 Geology

This section discusses the potential effects of the spent nuclear fuel management alternatives on geologic resources at the INEL site.

Proposed INEL spent nuclear fuel management activities would only have minor localized impacts on the geology of the site for all the alternatives. Direct impacts to geologic resources at the site would be associated with the disturbance or extraction of surface deposits to construct new facilities. These impacts could include excavations into the soil and rock of the site, soil mounding and banking, and the extraction of aggregate materials from gravel and borrow pits on the site. Table 5.6-1 lists estimated extractions of aggregate from site gravel pits for all INEL spent nuclear fuel, environmental restoration, and waste management projects. These values serve to bound the spent nuclear fuel project usage.

A secondary impact to geological resources from construction activities would be the potential for increased soil erosion. DOE would minimize any potential soil erosion by the use of Best Management Practices designed to control stormwater runoff and slope stability.

Table 5.6-1. Estimated INEL gravel/borrow use (cubic meters).[a,b]

	Alternative	Estimated Gravel/Borrow Use
1.	No Action	158,000
2.	Decentralization	158,000
3.	1992/1993 Planning Basis	392,000
4a.	Regionalization by Fuel Type	392,000
4b(1)	Regionalization by Geography (INEL)	1,772,000
4b(2)	Regionalization by Geography (Elsewhere)	296,000
5a.	Centralization at other DOE Sites	296,000
5b.	Centralization at the INEL	1,772,000

a. Source: EG&G (1994).
b. To convert cubic meters to cubic yards, multiply by 1.31.

5.7 Air Quality and Related Consequences

This section describes the potential nonradiological and radiological impacts to air quality associated with each alternative. The term "baseline concentrations" is defined as the sum of the concentrations resulting from potential emissions from current operations and those resulting from planned upgrades or modifications that DOE would construct or operate prior to any of the proposed actions described in this EIS. Additional information is provided in Section 5.7 and Appendix F-3 of Volume 2.

5.7.1 Alternative 1 - No Action

5.7.1.1 Nonradiological Air Quality. Construction activities associated with this alternative would be limited to upgrading an existing facility. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. DOE assessed the impacts from construction using the EPA Fugitive Dust Model (FDM) (Winges 1992). The modeling results showed that the expected construction-related air quality impacts should be temporary and highly localized.

Minimal spent nuclear fuel activities would occur under this alternative. Therefore, DOE expects that the ambient concentrations levels from normal operations would be similar to those from baseline. Table 4.7-1 lists nonradioactive emissions from normal operations. Tables 5.7-1 and 5.7-2 list the maximum potential concentrations for the proposed alternatives; they are all below applicable standards and guidelines. Ambient concentrations from Alternative 1 activities will be below applicable standards and guidelines.

5.7.1.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

No additional facilities that would be in operation for this alternative would produce radionuclide emissions. Therefore, for normal operations, doses to the maximally exposed individual, the population, and workers would be equivalent to baseline doses, as listed in Table 5.7-3. Table 5.7-4 lists associated emission rates.

Table 5.7-1. Maximum impacts to nonradiological air quality from spent nuclear fuel - criteria pollutants.[a,b]

Pollutant	Averaging time	Applicable standard ($\mu g/m^3$)	Maximum baseline concentration ($\mu g/m^3$)	Baseline plus maximum alternative[c] ($\mu g/m^3$)	Percent of standard
Carbon monoxide	1-hr	40,000	610	610	1.5
	8-hr	10,000	280	280	2.8
Nitrogen dioxide	Annual	100	4	4	4
Lead	Quarterly	1.5	0.001	0.001	<0.1
Particulate matter (PM_{10})	24-hr	150	80	80	53
	Annual	50	5	5	10
Sulfur dioxide	3-hr	1,300	580	580	45
	24-hr	365	140	140	38
	Annual	80	6	6	7.5

a. Source: Section 5.7 of Volume 2 of this EIS and Belanger et al. (1995).
b. Listed concentrations are the maximum of those calculated at the INEL site boundary, public access roads inside the INEL site boundary, and the Craters of the Moon Wilderness Area.
c. The listed concentrations are the maximums for any of the proposed alternatives.

Table 5.7-2. Maximum impacts to nonradiological air quality from spent nuclear fuel - toxic air pollutants.[a,b]

Pollutant	Averaging time	Applicable standard ($\mu g/m^3$)	Maximum baseline concentration ($\mu g/m^3$)	Impact from maximum alternative[c] ($\mu g/m^3$)	Percent of standard[d]
Ammonia	Annual	1.8×10^{2}	6.0×10^{0}	1.8×10^{0}	1
Benzene	Annual	1.2×10^{-1}	2.9×10^{-2}	2.3×10^{-2}	19
Formaldehyde	Annual	7.7×10^{-2}	1.2×10^{-2}	4.4×10^{-2}	57
Methyl isobutyl ketone	Annual	2.1×10^{3}	(e)	2.6×10^{1}	1
Hydrofluoric acid	Annual	2.5×10^{1}	(e)	1.8×10^{-2}	<0.1
Tributylphosphate	Annual	2.5×10^{1}	(e)	6.1×10^{-2}	0.2

a. Source: Section 5.7 of Volume 2 of this EIS and Raudsep (1995).
b. Listed concentrations are the maximum of those calculated at the INEL site boundary, public access roads inside the INEL site boundary, and the Craters of the Moon Wilderness Area.
c. The listed concentrations are the maximums for any of the proposed alternatives, plus new or modified sources expected to become operational after May 1, 1994.
d. In accordance with State of Idaho regulations for toxic air pollutants, the percent of standard is calculated based on concentrations [illegible]ting from the alternatives and from new or modified sources that have become operational since May 1, [illegible].
e. Baseline concentrations for these pollutants were not analyzed because their emissions were below screening levels.

Table 5.7-3. Annual dose increments by alternative in comparison to the baseline.[a]

Alternative		INEL worker (millirem)	Maximally exposed individual (millirem)	Population (person-rem)[b]
Baseline		4.3×10^{0}[c]	5.6×10^{-2}	3.4×10^{-1}
1.	No Action	3.3×10^{-4}	3.5×10^{-3}	1.0×10^{-1}
2.	Decentralization	3.3×10^{-4}	3.5×10^{-3}	1.0×10^{-1}
3.	1992/1993 Planning Basis[c]	3.3×10^{-3}	8.0×10^{-3}	1.9×10^{-1}
4a.	Regionalization by Fuel Type	3.3×10^{-3}	8.0×10^{-3}	1.9×10^{-1}
4b(1).	Regionalization by Geography (INEL)[d]	4.2×10^{-3}	4.8×10^{-2}	3.9×10^{-1}
4b(2).	Regionalization by Geography (Elsewhere)	7.0×10^{-5}	3.9×10^{-3}	8.3×10^{-2}
5a.	Centralization at Other DOE Sites	7.0×10^{-5}	3.9×10^{-3}	8.3×10^{-2}
5b.	Centralization at the INEL	4.2×10^{-3}	4.8×10^{-2}	3.9×10^{-1}

a. Source: Section 5.7 of Volume 2 of this EIS.
b. Population dose is calculated based on the projected population in 2000 or 2010 whichever is higher.
c. Baseline worker dose includes the maximum projected operation of the portable water treatment unit at the Power Burst Facility area. However, the operation would be temporary (1 to 2 years) and is not representative of a permanent increase in the baseline. If this facility were not included, the baseline dose to the worker would be about 0.2 millirem per year.
d. Alternative 4b(1) doses are slightly less than Alternative 5b doses.

5.7.2 Alternative 2 - Decentralization

5.7.2.1 Nonradiological Air Quality. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. The modeling assessment showed that the expected construction-related air quality impacts should be temporary and highly localized.

Emissions resulting from normal operations under this alternative would include baseline emissions and those resulting from the startup of the proposed facilities. Emission rates associated with startup would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7-2 list the maximum concentrations predicted for the proposed alternatives. Ambient concentrations from Alternative 2 activities would be below applicable standards and guidelines.

Table 5.7-4. Radionuclide emissions by alternative for spent nuclear fuel projects.[a]

Project and Location	Associated Alternative	Radionuclides and Emission Rates (Ci/yr)										
		H-3/ C-14	Co-60	Kr-85	Xe-131m/ Xe-133	Sr-90/ Y-90	Sb-125	I-129/ I-131	Cs-134 Cs-137	Plutonium	Am-241	Others
TAN Pool Fuel Transfer Project	1, 2, 3, 4a											
a. Drying operations	4b(1), 5b	9.6×10^{2}	-	-	-	2.9×10^{-2}	-	3.4×10^{-2}	-	6.6×10^{-4}	2.2×10^{-4}	-
b. Storage operations		3.9×10^{-1}	-	-	-	-	-	-	-	-	-	-
(Test Area North)												
Additional Increased Rack Capacity (Idaho Chemical Processing Plant)	3, 4a, 4b(1), 5b	2.0×10^{-1}	1.2×10^{-8}	-	-	3.8×10^{-7}	1.0×10^{-4}	-	1.3×10^{-5}	-	-	3.1×10^{-6}
Dry Fuels Storage Facility (Idaho Chemical Processing Plant)	3, 4a, 4b(1), 4b(2), 5a, 5b	1.8×10^{-2}	1.9×10^{-6}	-	-	1.8×10^{-5}	2.2×10^{-1}	4.2×10^{-1}	6.8×10^{-7}	2.6×10^{-7}	-	1.9×10^{-5}
Fort St. Vrain Spent Fuel Storage (Idaho Chemical Processing Plant)	3, 4a, 4b(1), 5b	-	5.6×10^{-8}	-	-	1.8×10^{-6}	-	-	2.4×10^{-7}	5.6×10^{-7}	-	2.4×10^{-7}
Increased Rack Capacity (Idaho Chemical Processing Plant)	3, 4a, 4b(1), 5b	2.0×10^{-1}	1.2×10^{-8}	-	-	3.8×10^{-7}	1.0×10^{-4}	-	1.3×10^{-5}	-	-	3.1×10^{-6}
EBR-II Blanket Treatment (Argonne National Laboratory - West)	3, 4a, 4b(1), 5b	1.6×10^{2}	-	4.9×10^{3}	5.1×10^{1}	-	-	-	-	-	-	-
Electrometallurgical Process Demonstration Project (Argonne National Laboratory - West)	3, 4a, 4b(1), 4b(2), 5a, 5b	8.4×10^{2}	-	1.4×10^{4}	1.3×10^{2}	-	-	-	-	-	-	-
Spent Fuel Processing Facility	4b(1), 5b	3.1×10^{3}	1.9×10^{-6}	5.0×10^{5}	-	5.8×10^{-2}	1.6×10^{1}	4.4×10^{-1}	1.8×10^{-1}	7.7×10^{-3}	-	2.1×10^{-1}

a. Source: Appendix F-3 of Volume 2 of this EIS.

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5.7.2.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

Emissions resulting from normal operations under this alternative would include the baseline emissions and those resulting from the startup of the proposed facilities. Table 5.7-4 lists emission rates for the spent nuclear fuel alternatives, including Decentralization. Table 5.7-3 lists the resulting doses to the maximally exposed individual, the population, and workers. These values are small in comparison to the National Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year, the dose limit received from background sources of 351 millirem per year, and the population dose from background sources of 40,000 person-rem.

5.7.3 Alternative 3 - 1992/1993 Planning Basis

5.7.3.1 Nonradiological Air Quality. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. The modeling assessment showed that expected construction-related air quality impacts should be temporary and highly localized.

Emissions resulting from normal operations under this alternative would include baseline emissions and those resulting from the proposed facilities. Emission rates associated with startup would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7-2 list the maximum potential concentrations for the proposed alternatives. Ambient concentrations from Alternative 3 activities would be below applicable standards and guidelines.

5.7.3.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

Emissions resulting from normal operations under this alternative would include baseline emissions and those resulting from the startup of the proposed facilities. Table 5.7-4 lists emission rates for the spent nuclear fuel alternatives. Table 5.7-3 lists the resulting doses to the maximally exposed individual, the population, and workers. These values are small in comparison to the National Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year, the dose limit received from background sources of 351 millirem per year, and the population dose from background sources of 40,000 person-rem.

5.7.4 Alternative 4a - Regionalization by Fuel Type

5.7.4.1 Nonradiological Air Quality. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. The modeling assessment showed that the expected construction-related air quality impacts should be temporary and highly localized.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the startup of the proposed facilities. Emission rates associated with startup would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7-2 list the maximum potential concentrations for the proposed alternatives. Ambient concentrations from Alternative 4 activities would be below applicable standards and guidelines.

5.7.4.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the proposed facilities. Table 5.7-4 lists emission rates for spent nuclear fuel alternatives including Regionalization. Table 5.7-3 lists the resulting doses to the maximally exposed individual, the population, and workers. These values are small in comparison to the National Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year, the dose limit received from background sources of 351 millirem per year, and the population dose from background sources of 40,000 person-rem.

5.7.5 Alternative 4b(1) - Regionalization by Geography (INEL)

5.7.5.1 Nonradiological Air Quality. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. The modeling assessment showed that the expected construction-related air quality impacts should be temporary and highly localized.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the startup of the proposed facilities. Emission rates associated with startup would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7-2 list the maximum potential concentrations from the proposed alternatives. Ambient concentrations from Alternative 4b(1) activities would be below applicable standards and guidelines.

5.7.5.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the proposed facilities. Table 5.7-4 lists associated emission rates for spent nuclear fuel alternatives including Regionalization by Geography (INEL). Table 5.7-3 lists resulting doses to the maximally exposed individual, the population, and workers. These values are small in comparison to the National Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year, the dose limit received from background sources of 351 millirem per year, and the population dose from background sources of 40,000 person-rem.

5.7.6 Alternative 4b(2) - Regionalization by Geography (Elsewhere)

5.7.6.1 Nonradiological Air Quality. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. The modeling assessment showed that the expected construction-related air quality impacts should be temporary and highly localized.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the startup of the proposed facilities. Emission rates associated with startup would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7-2 list the maximum potential concentrations from the proposed alternatives. Ambient concentrations from Alternative 4b(2) activities would be below applicable standards and guidelines.

5.7.6.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the proposed facilities. Table 5.7-4 lists associated emission rates for spent nuclear fuel alternatives including Regionalization by Geography (Elsewhere). Table 5.7-3 lists resulting doses to the maximally exposed individual, the population, and workers. These values are small in comparison to the National Emission Standards for Hazardous Air Pollutants dose limit of

10 millirem per year, the dose limit received from background sources of 351 millirem per year, and the population dose from background sources of 40,000 person-rem.

5.7.7 Alternative 5a - Centralization at Other DOE Sites

5.7.7.1 Nonradiological Air Quality. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. The modeling assessment showed that the expected construction-related air quality impacts should be temporary and highly localized.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the startup of the proposed facilities. Emission rates associated with startup would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7-2 list the maximum potential concentrations from the proposed alternatives. Ambient concentrations from Alternative 5a activities would be below applicable standards and guidelines.

5.7.7.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the proposed facilities. Table 5.7-4 lists associated emission rates for spent nuclear fuel alternatives including Centralization at other DOE sites. Table 5.7-3 lists resulting doses to the maximally exposed individual, the population, and workers. These values are small in comparison to the National Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year, the dose limit received from background sources of 351 millirem per year, and the population dose from background sources of 40,000 person-rem.

5.7.8 Alternative 5b - Centralization at the INEL

5.7.8.1 Nonradiological Air Quality. Potential impacts to air quality from construction activities would include fugitive dust and exhaust emissions from support equipment. The modeling assessment showed that the expected construction-related air quality impacts should be temporary and highly localized.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from the proposed facilities. Emission rates associated with the startup of the proposed facilities would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7-2 list the maximum potential concentrations from the proposed alternatives. Ambient concentrations from Alternative 5b activities would be below applicable standards and guidelines.

5.7.8.2 Radiological Air Quality. No radiological impacts to the environment would result from construction activities.

Emissions resulting from normal operation under this alternative would include baseline emissions and those resulting from startup of the proposed facilities. Table 5.7-4 lists associated emission rates for spent nuclear fuel alternatives including Centralization at the INEL. Table 5.7-3 lists resulting doses to the maximally exposed individual, the population, and workers. These values are small in comparison to the National Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year, the dose limit received from background sources of 351 millirem per year, and the population dose from background sources of 40,000 person-rem.

5.8 Water Resources and Related Consequences

This section discusses potential environmental consequences to water resources under the five spent nuclear fuel management alternatives. DOE evaluated each alternative with respect to its impacts on water quality (both surface and subsurface water), water use, and human health.

Any liquid effluents from facilities proposed for the spent nuclear fuel alternatives would be in tanks or lined evaporation basins. Under normal operating conditions, radioactive discharges to the soil or directly to the aquifer would not occur. Creed (1994) presents spent nuclear fuel water quality data for the analysis of the potential impacts resulting from a hypothetical leak of 20 liters (5 gallons) per day from secondary containment around the SNF storage pools during operations. Arnett (1994) addresses the effects that this leak could have on the quality of subsurface water resources. Preliminary results indicate that there will be no contaminants above maximum contaminant levels at the INEL boundary resulting from the postulated operational leak. Some storage pools have had leakage in the past. However, based on the bounding accident scenario for high-level waste tank failure, leakage during the implementation of the selected spent nuclear fuel management alternative would cause negligible impacts to water resources (Bowman 1994). None of the proposed alternatives for the management of spent nuclear fuel would result in any renewed discharges to infiltration ponds. Section 5.15 discusses potential releases of hazardous or radioactive liquids as a result of accidents.

With respect to water usage, Alternative 4b(1) [Regionalization by Geography (INEL)] and Alternative 5b (Centralization at the INEL) would consume the largest volume of water--1.5 million cubic meters (400 million gallons) over 40 years. The greatest water consumption rate for these alternatives would be 50,000 cubic meters (13 million gallons) per year (Hendrickson 1995). This incremental usage would represent approximately a 0.7 percent increase over the total average withdrawal rate at the INEL of 7.4 million cubic meters (1.9 billion gallons) per year. The INEL's consumptive use water right is 43 million cubic meters (11.4 billion gallons) per year. Therefore, Alternatives 4b(1) and 5b would have negligible impact on the quantity of water in the Eastern Snake River Plain Aquifer.

5.9 Ecology

DOE expects that construction impacts, which would include the loss of some wildlife habitat due to land clearing and facility development, would be greatest under Alternative 4b(1) [Regionalization by Geography (INEL)] and Alternative 5b (Centralization at the INEL). Because this construction activity would take place either within the boundaries of heavily developed areas or adjacent to those areas, it would have minimal impact on ecological resources. However, construction activities could provide opportunities for the spread of exotic plant species (e.g., cheatgrass and Russian thistle).

There would be no construction impacts to wetlands, which would be excluded from development, and impacts to threatened and endangered species would be unlikely, given the location (previously-developed areas) and the maximum size [approximately 31 acres (0.125 square kilometers)] of the affected area. Construction activities at the INEL probably would not affect either of the endangered species identified in Section 4.9.3 (the bald eagle and peregrine falcon). Both of these birds of prey are associated with riparian areas, wetlands, and larger bodies of water (e.g., reservoirs) and inhabit dry upland areas only temporarily when migrating (National Geographic Society 1987). Disturbance to other sensitive (but not Federally-listed) species identified in Section 4.9.3 (e.g., the burrowing owl, northern goshawk, ferruginous hawk, Swainson's hawk, gyrfalcon, Townsend's western big-eared bat, and pygmy rabbit) would be possible but unlikely, given the scale of the planned construction. Any impacts would be negligible and short lived, lasting only as long as the construction activities.

Representative impacts from operations would include the disturbance and displacement of animals (such as the pronghorn) caused by the movement and noise of personnel, equipment, and vehicles. Such impacts would be greatest under Alternative 4b(1) [Regionalization by Geography (INEL)] and Alternative 5b (Centralization at INEL), which would involve a generally higher level of operational activity; however, these impacts would be minor under all the proposed alternatives.

5.10 Noise

As discussed in Section 4.10, noises generated on the INEL do not travel off the site at levels that affect the general population. Therefore, INEL noise impacts for each alternative would be limited to those resulting from the transportation of personnel and materials to and from the site that would affect nearby communities, and from onsite sources that could affect wildlife near those sources.

Transportation noises would be a function of the size of the workforce (e.g., an increased workforce would result in increased employee traffic and corresponding increases in deliveries by truck and rail; a decreased workforce would result in decreased employee traffic and corresponding decreases in deliveries). This analysis of traffic noise considered railroad noise and noise from major roadways that provide access to the INEL. DOE does not expect the number of freight trains per day in the region and through the site to change as a result of any of the alternatives. Rail shipments of spent nuclear fuel, regardless of the alternative, would be a small fraction of the rail traffic on the Blackfoot-to-Arco Branch of the Union Pacific System line that crosses the INEL. The vehicles that transport employees and personnel on roads would be the principal source of community noise impacts near the INEL.

This analysis used the day-night average sound level to assess community noise, as suggested by the EPA (EPA 1974, 1982) and the Federal Interagency Committee on Noise (FICON 1992). The analysis based its estimate of the change in day-night average sound level from the baseline noise level for each alternative on projected changes in employment and traffic levels. The analysis also considers the combination of construction and operation employment. The baseline noise level is comparable to that for the No-Action alternative. Section 4.10 discusses levels representative of the No-Action alternative. The traffic noise analysis considered U.S. Highway 20, which employees use to access the INEL from Idaho Falls. Changes in noise level below 3 decibels probably would not result in a change in community reaction (FICON 1992).

The new employment associated with each alternative is a small percentage of the total onsite workforce. The maximum new employment of about 375 INEL onsite jobs would occur with Alternatives 3, 4a, 4b(1), and 5b during the peak construction period beginning in 2001 (see Section 5.3, Socioeconomics). No new operations employment is projected for any of the alternatives except Alternatives 4b(1) and 5b for which there would be 25 new jobs beginning in 2007. The cumulative onsite workforce under each alternative would be greatest in 1995 and would decrease

thereafter. The peak cumulative onsite workforce for Alternatives 4b(2) and 5a would increase in 1995 by less than 1 percent compared to the No-Action baseline. There would be a corresponding increase in private vehicle and truck trips to the site. The day-night sound level (DNL) at 15 meters (50 feet) from the roads that provide access to the INEL probably would increase by less than 1 decibel. The peak cumulative onsite workforce for Alternative 2 in 1995 would be the same as that for the No-Action baseline.

For any of the alternatives, truck activity would consist of a few trips per day to and from the site carrying spent nuclear fuel. This increase in truck trips would not result in a perceptible increase in traffic noise levels along the routes to the INEL. The day-night average sound level along U.S. Highway 20 and other access routes probably would decrease slightly as a result of the anticipated overall decrease in employment levels at the INEL. DOE expects no change in the community reaction to noise along this route and other access routes. No mitigation efforts would be required.

5.11 Traffic and Transportation

5.11.1 Introduction

Spent nuclear fuel management activities involve the transportation of spent nuclear fuel inside the boundaries of the INEL (onsite) and on highways and rail systems outside the boundaries of the INEL (offsite). This section summarizes the methods of analysis used to determine the environmental consequences of onsite transportation of nonnaval spent nuclear fuel under normal conditions (incident-free) and of transportation accidents. The impacts include doses and health effects. Appendices D and I of Volume 1 address consequences of shipments to or from the INEL that involve other DOE sites and spent nuclear fuel-related locations.

5.11.2 Methodology

5.11.2.1 Incident-Free Transportation. Radiological impacts were determined for two groups of people during normal incident-free transportation: (1) crewmen (drivers) and (2) members of the public. Members of the public are persons sharing the transport link (on-link). On-link doses were determined for onsite shipments because members of the public have access to the majority of the roads on the INEL. Radiological impacts were calculated using the RADTRAN 4 (Neuhauser and Kanipe 1992) and RISKIND (Yuan et al. 1993) computer codes.

The magnitude of the incident-free dose depends mainly on the Transport Index of the shipment and the on-link vehicle densities. The Transport Index is defined as the dose rate at 1 meter (3.28 feet) from the surface of a radioactive package; it is measured in millirem per hour. Spent nuclear fuel was assigned a dose rate of 14 millirem per hour at 1 meter from the shipping container. This dose rate yielded a dose rate of 10 millirem per hour at 2 meters (6.56 feet) from the edge of the transport vehicle, which is the regulatory limit for an exclusive use vehicle (see Madsen et al. 1986).

Radiological doses were converted to cancer fatalities using risk conversion factors of 5.0×10^{-4} fatal cancer per person-rem for members of the public and 4.0×10^{-4} fatal cancers per person-rem for workers. These risk conversion factors are from Publication 60 of the International Commission on Radiological Protection (ICRP 1991).

Because the onsite transportation of spent nuclear fuel at the INEL is considered rural, no incident-free nonradiological risk (from exhaust emissions and dust resuspension) was calculated.

5.11.2.2 Accidents. The doses of the maximum reasonably foreseeable onsite spent nuclear fuel transportation accident were calculated using the RISKIND computer code. Doses were analyzed for generic rural and suburban population densities, assuming 6 persons per square kilometer for rural areas and 719 persons per square kilometer for suburban areas. Areas within 80 kilometers (50 miles) of INEL have population densities between rural and suburban but are closer to the generic rural population density. Doses were also assessed under both neutral and stable atmospheric conditions. Radiation doses calculated were used to estimate the potential for fatal cancers in the exposed population using risk factors developed by the International Commission on Radiological Protection (ICRP 1991).

The probability of the maximum reasonably foreseeable onsite spent nuclear fuel transportation accident was estimated taking into account spent nuclear fuel handling procedures within the Advanced Test Reactor facility as well as factors related to transportation of the spent nuclear fuel. For this accident to occur, errors must occur in loading the wrong spent nuclear fuel into the shipping cask, radiation surveys of the loaded cask fail to detect abnormally high radiation levels, the transport vehicle must breakdown or rollover during the short transit between the Advanced Test Reactor and the Idaho Chemical Processing Plant, and operators fail to ensure that adequate cooling water is maintained inside the cask. The estimated probability of this accident is no greater than once in a million years.

The risk of the onsite spent nuclear fuel transportation accident was estimated by multiplying the accident doses by the accident probability, taking into account the probability of the atmospheric conditions used. The resulting risk value gives a bounding estimate of the annual probability of fatal cancers occurring in the local population due to onsite spent nuclear fuel transportation accidents.

5.11.3 Onsite Spent Nuclear Fuel Shipments

For each spent nuclear fuel management alternative, a small number of onsite DOE spent nuclear fuel shipments would be likely each year as a result of continuing reactor operations at the Advanced Test Reactor and the Experimental Breeder Reactor-II. The alternatives would not affect the operation of these two facilities, thus the shipments between these facilities and the Idaho Chemical Processing Plant, integrated over 40 years, would be the same for each spent nuclear fuel management alternative.

Spent nuclear fuel shipments to the Idaho Chemical Processing Plant from four locations on the INEL (including the Test Reactor Area, Argonne National Laboratory-West, Test Area North, and Power Burst Facility) were evaluated. The number of shipments would not change with alternatives because DOE plans to ship all spent nuclear fuel to the Idaho Chemical Processing Plant. Alternatives that would ship spent nuclear fuel off the site under Regionalization [Alternatives 4a, 4b(1) and 4b(2)] and Centralization (Alterntives 5a and 5b) would ship it first to the Idaho Chemical Processing Plant for canning or other stabilization prior to shipment. DOE estimated the total projected number of shipments over 40 years of operation (1995-2035) from each facility from either historic records or current inventories. DOE based the projected number of shipments for Test Reactor Area and Argonne National Laboratory-West to the Idaho Chemical Processing Plant on historic records for 1987 through 1992, and the doses reflect shipments for 1995 through 2035. The projected number of shipments from Test Area North would include Three Mile Island canisters, Loss of Fluid Test fuel, special case commercial fuel, and non-fuel-bearing components stored in the Test Area North pool. The projected number of shipments from the Power Burst Facility includes all spent nuclear fuel stored at that facility.

Onsite shipments would include those that originated and ended on the INEL site. Shipments that originate or terminate at non-INEL facilities are offsite shipments. Appendixes D and I describe the consequences of naval and DOE offsite spent fuel shipments, respectively. Movements of spent nuclear fuel inside (INEL) facility fences (e.g., from the CPP-603 Underwater Storage Facility to the Fuel Storage Area) are operational transfers, not onsite shipments; therefore, this section does not consider such shipments.

5.11.4 Incident-Free Impacts

The occupational and general population collective doses from onsite spent nuclear fuel shipments and the resulting incidence of latent cancer fatalities were calculated. The results are the same regardless of alternative. Occupational radiation exposure would potentially be 3.4 person-rem, resulting in 0.0014 latent cancer fatalities. General population exposure would potentially be 0.088 person-rem, resulting in 0.000044 latent cancer fatalities.

In addition to collective radiation exposure, the maximally exposed individual doses due to INEL onsite SNF shipments were calculated for a driver (occupational exposure), a person following a single shipment, and a person standing beside the road as a single shipment passes by (general member of the public). The calculated dose to a driver would be 1.7 rem, assuming that person drove all

shipments over 40 years. The calculated maximally exposed individual dose to a person following a single shipment covering the longest distance from Test Area North to the Idaho Chemical Processing Plant would be 0.015 millirem, and to a person exposed to passing shipment at a distance of 1 meter (3.28 feet), the dose would be 0.0014 millirem (Maheras 1995).

Traffic impacts for the spent nuclear fuel shipments were estimated from data in Heiselmann (1994). The maximum number of spent nuclear fuel shipments of 691 per year would occur with Alternative 5b, Centralization at the INEL. A maximum 23-percent increase in traffic volume per day would occur with this alternative, based on the estimates of the number of trips required for the transport of construction equipment, material, spent nuclear fuel, other wastes, and workers to and from the INEL. Even if this average daily traffic volume were to occur for 1 hour, the maximum traffic volume would increase to 145 vehicles per hour for US 20, US 26, Routes 33 and 22; this would not change the baseline level of service, which is designated as "free flow."

5.11.5 Accident Impacts

An onsite spent nuclear fuel transportation accident involving the inadvertent shipment of a short-cooled fuel element from the Advanced Test Reactor to the Idaho Chemical Processing Plant was considered to be the maximum reasonably foreseeable accident. The melted spent nuclear fuel has potential to relocate into a critical configuration. However, the probability of a criticality accident is much less than 1×10^{-7} per year and would be considered to be not reasonably foreseeable. Table 5.11-1 lists the calculated maximally exposed individual dose and collective dose to general population in the maximally impacted sector and corresponding risk of fatal cancers. The dose to the maximally exposed individual is considered an occupational exposure.

As listed in Table 5.11-1, the total number of fatal cancers expected in the suburban population affected by the transportation for neutral and stable meteorological conditions would be 11 and 85, respectively. For the neutral case, this would represent a 0.01-percent increase from the number of fatal cancers that would be likely from normal incidence in the affected population. For the stable case, this would represent a 0.20-percent increase from the number of fatal cancers that would be likely from normal incidence in the affected population.

The total number of fatal cancers expected in the rural population affected by the transportation for neutral and stable meteorological conditions would be 0.75 and 6.0, respectively. For the neutral

Table 5.11-1. Impacts from maximum reasonably foreseeable spent nuclear fuel transportation accident on INEL[a] (using generic rural and suburban population densities).

Population density category[b]	Meteorology[c]	Accident frequency[d] (events/yr)	Dose to MEI[e] (rem)	Offsite population dose (person-rem)	Risk of fatal cancer per year[f]
Rural	Neutral	1.0×10^{-6}	7.6×10^{1}	1.5×10^{3}	7.5×10^{-7} (7.5×10^{-1})
Rural	Stable	1.0×10^{-7}	2.5×10^{2}	1.2×10^{4}	6.0×10^{-7} (6.0×10^{0})
Suburban	Neutral	1.0×10^{-6}	7.6×10^{1}	2.1×10^{4}	1.1×10^{-5} (1.1×10^{1})
Suburban	Stable	1.0×10^{-7}	2.5×10^{2}	1.7×10^{5}	8.5×10^{-6} (8.5×10^{1})

a. Source: Enyeart (1994).
b. Results are for generic rural and suburban population densities. The generic rural population density has an average population of 6 persons per square kilometer; the generic suburban population density has an average population of 719 persons per square kilometer. For comparison, the sector with the highest population density within 80 kilometers (50 miles) is due east of the Idaho Chemical Processing Plant and Test Reactor Area at the INEL with an average population density of 53 persons/km^2.
c. Neutral meteorology is characterized by Stability Class D, 4 meters-per-second wind speed, and occuring approximately 50 percent of the time. Stable meteorology is characterized by Stability Class F, 1 meter-per-second wind speed, and occuring approximately 5 percent of the time.
d. Accident frequency includes both the event frequency and the frequency of the meteorology. The frequency of stable meteorology is approximately one-tenth the frequency of neutral meteorology.
e. Maximally exposed individual located at the point of maximum exposure to the airborne release approximately 160 to 390 meters (525 to 1,280 feet) downwind, depending on meteorology. For onsite accidents the maximally exposed individual is assumed to be an INEL worker.
f. Fatal cancer risk = dose times accident frequency times (ICRP 60 risk factor for fatal cancers). The ICRP 60 risk factor is 5.0×10^{-4} fatal cancer per rem for public, 4.0×10^{-4} fatal cancer per rem for workers. For doses of 20 rem or more, the ICRP 60 conversion factor is doubled. Numbers in parentheses indicate the total number of fatal cancers in the population if the accident occurs. The maximally exposed individual dose is considered an occupational exposure.

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case, this would represent a 0.09-percent increase from the number of fatal cancers that would be likely from normal incidences in the affected population. For the stable case, this would represent a 1.7-percent increase from the number of fatal cancers that would be likely from normal incidence in the affected population.

The estimated maximum nonradiological occupational and general population traffic fatalities over 40 years due to any of the spent nuclear fuel management alternatives would be 7.1×10^{-4} and 2.5×10^{-3}, respectively. These estimated fatalities were based on fatality risk factors for spent fuel shipments (Cashwell et. al 1986).

5.11.6 Onsite Mitigative and Preventative Measures

All onsite shipments would be in compliance with DOE ID Directive 5480.3, "Hazardous Materials Packaging and Transportation Safety Requirements." These requirements provide assurance that, under normal conditions, the INEL would meet as-low-as-reasonably-achievable conditions, reasonably foreseeable accident situations (those with a probability of occurrence greater than 1×10^{-7} per year) would not result in a loss of shielding or containment or a criticality, and an unintentional release of radioactive material would generate a timely response.

DOE would approve the type packages used for onsite shipments or would obtain a Nuclear Regulatory Commission or DOE certificate of compliance. If the Type B onsite package did not have Nuclear Regulatory Commission or DOE certification, the user of the package would have to establish how administrative controls and site-mitigating circumstances would ensure that the package would maintain containment and shielding integrity. The administrative and emergency response considerations would provide sufficient control so that accidents would not result in loss of containment or shielding, in criticality, or in an uncontrolled release of radioactive material that would create a hazard to the health and safety of the public or workers.

In the event of an accident, each DOE site has an established emergency management program. This program incorporates activities associated with emergency planning, preparedness, and response. Participating government agencies with plans that are interrelated with the INEL Emergency Plan for Action include the State of Idaho, Bingham County, Bonneville County, Butte County, Clark County, Jefferson County, the Bureau of Indian Affairs, and Fort Hall Indian Reservation. When an emergency condition exists at a facility, the Emergency Action Director is responsible for recognition, classification, notification, and protective action recommendations. At INEL emergency preparedness

resources include fire protection, radiological and hazardous chemical material response, emergency control center, the INEL Warning Communication Center, the INEL Site Emergency Operational Center, and medical facilities.

5.12 Occupational and Public Health and Safety

This section presents DOE's estimates of the health effects from spent nuclear fuel-related activities at the INEL for the following human receptor groups:

- Involved Workers - workers at the facilities involved with spent nuclear fuel alternatives, including existing workers and new hires for selected alternative
- Maximally Exposed Individual (MEI) - person residing at the INEL site boundary
- Population - the general offsite population in the INEL region
- Construction Worker - labor force associated with construction activities
- Nonconstruction Worker - DOE labor force associated with nonconstruction activities

Radiological, chemical, and industrial safety hazards were considered in the estimates.

5.12.1 Radiological Exposure and Health Effects

The measure of impact used for evaluation of potential radiation exposures is risk of fatal cancers. Worker and maximally exposed individual effects are reported as individual radiation dose (in rem) and the estimated lifetime probability of fatal cancer. Population effects are reported as collective radiation dose (in person-rem) and the estimated number of fatal cancers in the affected population. Tables 5.12-1, 5.12-2, 5.12-3, and 5.12-4 summarize the radiological health effects calculations for each alternative.

Activities that workers would perform under each of the alternatives would be similar to those currently performed at the INEL. Therefore, the potential hazards encountered in the workplace would be similar to those that currently exist at the INEL. Further, DOE would mitigate these hazards with occupational and radiological safety programs operating under the same regulatory standards and limits that currently apply at the INEL. For these reasons, DOE anticipates that the average radiation dose

Table 5.12-1. Annual occupational radiation exposure and employment summary.[a]

	No Action (1)	Decentralization (2)	1992/1993 Planning Basis (3)	Regionalization by Fuel Type (4a)[b]	Centralization at Other DOE Sites (5a)	Centralization at the INEL (5b)
Number of Workers (annual average over years 1995-2004)[c]	1	1	200	200	10	200
Worker Collective Dose[d] (person-rem/year)	0.027	0.027	5.4	5.4	0.27	5.4

a. Source: Johnson (1995).
b. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as those for Alternative 5b. Alternative 4b(2), Regionalization by Geography (Elsewhere), values are the same as those for Alternative 5a.
c. This 10-year average yields conservatively high employment; the 40-year average would be lower but data do not exist.
d. Based on thermoluminescence dosimetry records.

Table 5.12-2. Annual nonoccupational radiation exposure summary.

	No Action (1)	Decentralization (2)	1992/1993 Planning Basis (3)	Regionalization by Fuel Type (4a)[b]	Centralization at Other DOE Sites (5a)	Centralization at the INEL (5b)
MEI Dose (mrem/year)	3.5×10^{-3}	3.5×10^{-3}	8.0×10^{-3}	8.0×10^{-3}	3.9×10^{-3}	4.8×10^{-2}
Population Dose[a] (person-rem/year)	1.0×10^{-1}	1.0×10^{-1}	1.9×10^{-1}	1.9×10^{-1}	8.3×10^{-2}	3.9×10^{-1}

a. Population dose is calculated based on the projected population in 2000.
b. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as those for Alternative 5b. Alternative 4b(2), Regionalization by Geography (Elsewhere), values are the same as those for Alternative 5a.

Table 5.12-3. Annual fatal cancer incidence and probability summary from radiological exposure.[a]

	No Action (1)	Decentralization (2)	1992/1993 Planning Basis (3)	Regionalization by Fuel Type(4a)[b]	Centralization at Other DOE Sites (5a)	Centralization at the INEL (5b)
Worker						
probability	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}
incidence	1×10^{-5}	1×10^{-5}	2×10^{-3}	2×10^{-3}	1×10^{-4}	2×10^{-3}
Maximally exposed member of the public						
probability	2×10^{-9}	2×10^{-9}	4×10^{-9}	4×10^{-9}	2×10^{-9}	2×10^{-8}
Population						
incidence	5×10^{-5}	5×10^{-5}	1×10^{-4}	1×10^{-4}	4×10^{-5}	2×10^{-4}

a. Risk factors for the worker (4×10^{-4} probability of occurrence per rem) or offsite population (5×10^{-4} probability of occurrence per rem) recommended by the International Commission on Radiological Protection (ICRP 1991).
b. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as those for Alternative 5b. Alternative 4b(2), Regionalization by Geography (Elsewhere), values are the same as those for Alternative 5a.

Table 5.12-4. 40-year fatal cancer incidence summary from radiological exposure.[a]

	No Action (1)	Decentralization (2)	1992/1993 Planning Basis (3)	Regionalization by Fuel Type (4a)	Centralization at Other DOE Sites (5a)	Centralization at the INEL (5b)
Workers incidence	4×10^{-4}	4×10^{-4}	8×10^{-2}	8×10^{-2}	4×10^{-3}	8×10^{-2}
Population incidence	2×10^{-3}	2×10^{-3}	4×10^{-3}	4×10^{-3}	2×10^{-3}	8×10^{-3}

a. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as those for Alternative 5b. Alternative 4b(2), Regionalization by Geography (Elsewhere), values are the same as those for Alternative 5a.

and the number of reportable cases of injury and illness would be proportional to the number of workers at the INEL under each alternative.

Table 5.12-1 lists involved worker doses based on an historic annual average dose of 27 mrem determined from thermoluminescent dosimeter data of workers involved in various INEL radiological work over the period 1987 to 1991 (see Appendix F of Volume 2). As mentioned above, the hazards associated with spent nuclear fuel activities are the same as the hazards associated with other INEL activities. Table 5.12-2 lists the exposure summaries for the maximally exposed individual and offsite population, based on radioactive emissions from normal operations and those resulting from startup of proposed facilities for the various alternatives. Note that population collective dose is higher than worker collective dose only under alternatives 1 and 2. For the alternatives, there is only 1 SNF worker averaged over 40 years. The nonoccupational population has more people to be exposed. When the worker population increases under Alternatives 3, 4, and 5, the worker dose becomes higher than the population dose. Section 5.7 presents the exposure information. Dose calculations are based on air emissions only, and not water pathways because none of the alternatives would involve the discharge of pollutants to surface waters or to the subsurface. Section 5.8 summarizes water quality.

Table 5.12-3 summarizes the fatal cancer incidence and probability for workers, maximally exposed individuals, and the offsite population based on the risk factors consistent with those recommended by the International Commission on Radiological Protection (ICRP 1991). For all alternatives, the probability of developing fatal cancer for any individual would be low, with the maximum value of 1×10^{-5} for the involved worker. The calculated incidence of fatal cancer for the total number of workers for each alternative and the offsite population would be less than 1.

Table 5.12-4 summarizes the 40-year projection of fatal cancer incidence associated with the worker and offsite populations. The highest involved worker and offsite population incidence, 0.1 and 0.01, respectively, would be associated with Alternative 5b.

Radiation doses associated with construction activities would be as low as reasonably achievable and no greater than 2 rem per year to any worker. Historical offsite doses associated with the INEL are summarized in the Idaho National Engineering Laboratory Historical Dose Evaluation (DOE 1991). The Centers for Disease Control and Prevention is conducting a more comprehensive reconstruction of doses from INEL operations.

5.12.2 Nonradiological Exposure and Health Effects

The air quality data listed in Tables 5.7-1 and 5.7-2 were used to evaluate health impacts associated with potential exposure to two compound classes, criteria pollutant and toxic. Table 5.7-1 lists five pollutant criteria and Table 5.7-2 lists six toxic air pollutant compounds. The toxic compounds were classified as noncarcinogens or carcinogens, consistent with EPA designations published in the Integrated Risk Information System (IRIS) data base. However, the IRIS data base does not include sufficient data to perform a quantitative inhalation cancer risk assessment.

Nonradiological health effects (hazard indices) for the INEL worker or maximally exposed individual were estimated by summing the ratios of the appropriate pollutant concentrations and their applicable standards presented in Table 5.7-1 and Table 5.7-2. Table 5.7-1 presents criteria pollutant concentrations at public access roads, which are the maximum of those calculated at the INEL site boundary, public access roads inside the INEL site boundary, and the Craters of the Moon Wilderness Area. The hazard index for the five criteria pollutants is less than 1 (0.2) for the workers or the maximally exposed individual, based on concentrations for the longest averaging times presented in Table 5.7-1. Table 5.7-2 presents toxic air pollutant concentrations at the public access roads, which are the maximum when compared with concentrations at the INEL site boundary and the Craters of the Moon Wilderness Area. The hazard index for the toxic air pollutants is also less than 1 (0.8) for the workers or the maximally exposed individual, based on concentrations with annual averaging time consideration. Accordingly, health effects are unlikely for either the criteria pollutants or the toxic air pollutants from spent nuclear fuel-related activities. The hazard index is not a statistical probability; therefore, it cannot be interpreted as such.

5.12.3 Industrial Safety

This section describes the following measures of impact for workplace hazards: (1) total reportable injuries and illness and (2) fatalities in the work force. This analysis considered injury and fatality rates for construction workers only since the alternatives do not result in incremental changes in operations employment. Table 5.12-5 lists the maximum annual number of projected injuries and illnesses and fatalities for construction workers by alternatives based on the maximum employment levels for any year between 1995-2035.

Table 5.12-5. Annual industrial safety health effects incidence summary.[a,b]

	No Action (1)	Decentralization (2)	1992/1993 Planning Basis (3)	Regionalization by Fuel Type (4a)[c]	Centralization at other DOE Sites (5a)	Centralization at the INEL (5b)
Construction workers						
Injury/illness	0	0	23	23	3	23
Fatality	0	0	<1	<1	<1	<1

a. 1988-1992 averages for occupational injury/illness and fatality rates for DOE and contractor employees.
b. Sources: DOE (1993b) and Section 5.3 of this appendix.
c. Alternative 4b(1) values are the same as those for Alternative 5b. Alternative 4b(2) values are the same as those for Alternative 5a.

5.13 Idaho National Engineering Laboratory Services

This section discusses the potential impacts from spent nuclear fuel management on utilities and energy at the INEL. It considers the consumption of water, electrical energy, fossil-based fuels, and wastewater discharge at the INEL site.

5.13.1 Construction

Table 5.13-1 summarizes estimates of annual requirements for electricity, water, wastewater, and diesel fuel for construction activities associated with each alternative and compares them to projected 1995 use levels for these resources. In general, the smallest increase in the demand for site services would result from Alternatives 4b(2) and 5a [Regionalization by Geography (Elsewhere) and Centralization at Other DOE Sites] and the largest increase would be associated with Alternatives 4b(1) and 5b [Regionalization by Geography (INEL) and Centralization at INEL].

Table 5.13-1. Estimated increase in annual electricity, water, wastewater treatment, and fuel requirements for construction activities associated with each alternative.

Service	Projected 1995 usage w/o Alternative	Estimated additional demand construction			
		Alternatives 1 and 2	Alternatives 3 and 4a	Alternatives 4b(1) and 5b	Alternatives 4b(2) and 5a
Electricity (MWH[a] per year)	208,000	71	150	2,100	10
Water (millions of liters per year)[b]	6,450	No increase	2.1	2.2	0.5
Sanitary wastewater (millions of liters per year)	540	No increase	1.5	4.5	0.5
Diesel fuel (liters per year)	5,830,000	6,400	8,500	14,000	1,500

a. MWH = megawatt hours.
b. To convert liters to gallons, multiply by 0.264.
Source: Hendrickson (1995).

Under Alternatives 4b(1) and 5b, the estimated annual increases in utility and energy usage rates from construction activities would be 2,100 megawatt-hours of electricity, 2.2 million liters (580,000 gallons) of water, 4.5 million liters (1,200,000 gallons) of wastewater discharge, and 14,000 liters (3,700 gallons) of diesel fuel. These changes represent modest increases ranging from near zero percent to 1.0 percent above projected 1995 usage levels and are well within current system capabilities and usage limits (see Section 4.13). The other alternatives would result in smaller increases in energy usage and would have no adverse impact on utility services at the INEL.

5.13.2 Operations

Table 5.13-2 summarizes estimates of annual requirements for electricity, water, wastewater, and fuel for operations activities associated with each alternative and compares them to project 1995 INEL usage of these resources. In general, the smallest increase in the demand for site services would result from Alternatives 1 and 2 (No-Action and Decentralization) and the largest would be associated with Alternatives 4b(1) and 5b [Regionalization by Geography (INEL) and Centralization at INEL].

Table 5.13-2. Estimated increase in annual electricity, water, wastewater treatment, and fuel requirements for operations activities associated with each alternative.

Service	Projected 1995 usage w/o Alternative	Estimated additional demand operation			
		Alternatives 1 and 2	Alternatives 3 and 4a	Alternatives 4b(1) and 5b	Alternatives 4b(2) and 5a
Electricity (MWH[a] per year)	208,000	180	2,200	11,000	2,000
Water (millions of liters per year)[b]	6,450	No increase	No increase	48	No increase
Sanitary wastewater (millions of liters per year)[c]	540	No increase	No increase	0.3	No increase
Fuel oil (liters per year)	11,100,000	28,000	330,000	1,100,000	300,000

a. MWH = megawatt hours.
b. To convert liters to gallons, multiply by 0.264.
c. Some industrial wastewater, such as steam condensate, is also discharged to evaporation ponds and injection wells.
Sources: Hendrickson (1995).

Under Alternatives 4b(1) and 5b, the estimated annual increases in utility and energy usage rates from operations activities would be 11,000 megawatt-hours of electricity, 48 million liters (13 million gallons) of water, 0.3 million liters (79,000 gallons) of wastewater, and 1,100,000 liters (290,000 gallons) of fuel oil. These changes represent modest increases ranging from near zero percent to 10 percent and are well within current system capabilities and usage limits (see Section 4.13). The other alternatives would result in smaller increases in energy usage and would have no adverse impact on utility services at the INEL.

5.14 Materials and Waste Management

This section discusses the impacts to the management of materials and wastes at the INEL site and Idaho Falls facilities as a result of the implementation of the spent nuclear fuel management alternatives. Alternatives 4b(1), and 5b, both with the spent fuel processing option, each establish the upper bound of potential impacts on projected rates of generation, treatment, storage, and disposal inventories of materials and wastes. Table 5.14-1 and 5.14-2 summarize waste generation projections for each alternative. The tables present average generating rates over the life cycle of each alternative and maximum annual increments over peak generation periods.

5.14.1 Alternative 1 - No Action

Under the No Action Alternative, 9 cubic meters of industrial solid waste would be generated during construction of the Alternate Fuel Storage Facility for the TAN Pool Fuel Transfer Project at the Idaho Chemical Processing Plant. At the completion of this project in 1998, there would be 485 cubic meters of non-fuel solid low-level waste consisting of Three Mile Island hardware and metals that would be removed and dispositioned in a separate project. These impacts apply also to the description of impacts for the other spent nuclear fuel management alternatives with the exception of Alternatives 4b(2) and 5a. The non-fuel solid low-level waste is already existing; therefore, it is not included in Table 5.14-1 as an increase in low-level waste generation.

5.14.2 Alternative 2 - Decentralization

In general, the character of the impacts to materials and waste management would be similar to those under the No Action Alternative.

5.14.3 Alternative 3 - 1992/1993 Planning Basis

Industrial solid waste would be generated from construction and operation of the various SNF projects under Alternative 3. This nonradioactive waste would be disposed of in the Central Facilities Area landfill. Landfill space is nonrestrictive for industrial solid waste disposal. Construction phase activities would generate a cumulative total of 620 cubic meters of industrial and commercial solid

Table 5.14-1. Average annual waste generation projections for selected SNF management alternatives at INEL.[a]

		Average annual increment over 1995 baseline			
Alternative	Waste type	Phase	Period (years)	Increase (percent)	Annual rate (cubic meters per year)
No Action (Alternative 1) and Decentralization (Alternative 2)	Industrial	Construction	1995-1996	0.02	9
1992/1993 Planning Basis (Alternative 3) and Regionalization by Fuel Type (Alternative 4a)	Industrial	Construction	1995-2005	0.1	62
		Operation	1996-2035	1.2	600
	Low-Level[b,c]	Construction	1995-1999	8.6	370
		Operation	1996-2035	4.6	200
	High-Level	Operation	1996-2024	0.1	3
	Mixed Low-Level	Operation	1996-2024	<0.1	<1
	Transuranic	Operation	1996-2024	530	32
Regionalization by Geography (INEL) [Alternative 4b(1)] and Centralization at INEL (Alternative 5b)	Industrial	Construction	1995-2008	0.6	290
		Operation	1996-2035	5.0	2,600
	Low-Level[b,c]	Construction	1995-1999	8.6	370
		Operation	1996-2035	9.6	410
	High-Level	Operation	1996-2035	15.7	120
	Mixed Low-Level	Operation	1996-2024	<0.1	<1
	Transuranic	Operation	1996-2024	530	32
Regionalization by Geography (Elsewhere) [Alternative 4b(2)] and Centralization at Other DOE Sites (Alternative 5a)	Industrial	Construction	1995-1996	<0.1	50
		Operation	1996-2024	0.4	210
	Low-Level	Operation	1996-2024	1.9	83
	High-Level	Operation	1996-2024	0.1	3
	Mixed Low-Level	Operation	1996-2024	<0.1	<1
	Transuranic	Operation	1996-2024	530	32

a. Source: Appendix C of Volume 2 of this EIS.
b. Low-level waste from TAN Pool Fuel Transfer Project to be removed and dispositioned in a separate project not included for any alternatives.
c. Low-level waste generated from dispositioning and decontamination of fuel racks not included in any alternatives.

Table 5.14-2. Peak waste generation highlights for selected SNF management alternatives at INEL.[a]

Alternative	Waste type	Phase	Period (years)	Increase (percent)	Annual rate (cubic meters per year)
		Maximum increment over 1995 baseline			
No Action (Alternative 1) and Decentralization (Alternative 2)	Industrial	Construction	1995-1996	0.02	9
1992/1993 Planning Basis (Alternative 3) and Regionalization by Fuel Type (Alternative 4a)	Industrial	Construction	1995-1996	0.4	220
		Operation	2005-2021	1.6	810
	Low-Level[b,c]	Construction	1995-1997	13.4	570
		Operation	2005-2024	6.1	260
		Concurrent Activity[d]	1996-1997	14.2	610
	High-Level	Operation	1997-1998	0.2	6
	Mixed Low-Level	Operation	1997-1998	<0.1	<1
	Transuranic	Operation	1997-1998	600	36
Regionalization by Geography (INEL) [Alternative 4b(1)] and Centralization at INEL (Alternative 5b)	Industrial	Construction	1999-2006	0.9	450
		Operation	2008-2021	6.8	3,500
	Low-Level[b,c]	Construction	1995-1997	13.4	570
		Operation	2008-2024	13.3	570
		Concurrent Activity[d]	1996-1997	14.2	610
	High-Level	Operation	2005-2024	21.1	160
	Mixed Low-Level	Operation	1997-1998	<0.1	<1
	Transuranic	Operation	1997-1998	600	36
Regionalization by Geography (Elsewhere) [Alternative 4b(2)] and Centralization at Other DOE Sites (Alternative 5a)	Industrial	Construction	1995-1996	<0.1	50
		Operation	1996-2024	0.4	210
	Low-Level	Operation	1996-2010	3.1	130
	High-Level	Operation	1996-2024	0.1	3
	Mixed Low-Level	Operation	1996-2024	<0.1	<1
	Transuranic	Operation	1996-2024	530	32

a. ~~Source: Appendix C of Volume 2~~ of this EIS.
b. Low-level waste from TAN Pool Fuel Transfer Project to be removed and dispositioned in a separate project not included for any alternatives.
c. Low-level waste generated from dispositioning and decontamination of fuel racks not included in any alternatives.
d. Construction and operations occurring simultaneously.

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waste. The Fuel Receiving, Canning, Characterization, and Shipping Facility will generate the most industrial waste of any of the projects, 490 cubic meters per year from 2005 through 2035.

In addition, the Fuel Receiving, Canning, Characterization, and Shipping Facility will generate 220 cubic meters per year of low-level waste during the same period. The Dry Storage Facility would generate an additional 5 cubic meters of low-level waste annually from 2005 through 2035. Including liquid low-level waste, the Increased Rack Capacity and Additional Increased Rack Capacity projects would increase generation rates by 570 cubic meters annually during construction from 1995 through 1997. Low-level waste would decrease to approximately 160 cubic meters per year from 1997 through 1999 with the completion of the Increased Rack Capacity project. Liquid low-level waste would be disposed in existing liquid waste processing systems at the Idaho Chemical Processing Plant. Solid radioactive wastes would be packaged and disposed of at the Radioactive Waste Management Complex, or incinerated at the Waste Experimental Reduction Facility, whichever is appropriate. Low-level waste from reracking fuel racks for the Increased Rack Capacity Project will be decontaminated and dispositioned by a licensed commercial vendor.

Experimental Breeder Reactor-II Blanket Treatment will generate 7 cubic meters of low-level waste for 1 year from 1997 to 1998.

The storage of low-level waste for incineration is not considered to be restrictive between 1995 through 2005. However, beyond 2005, low-level waste storage capacity may become strained. Use of commercial facilities to incinerate the backlog of low-level waste is under consideration in order to reduce or prevent the accumulation of low-level waste, but no firm commitment or contract has yet been established (EG&G 1993a).

The Radioactive Waste Management Complex appears to have adequate disposal capacity for low-level waste between 1995 and 2005. However, beyond 2005, additional capacity may be required. Excess capacity would be provided with the development of the proposed Low-Level Waste/Mixed Low-Level Waste Disposal Facility (EG&G 1993a).

The Electrometallurgical Process Demonstration Project will generate high-level, mixed low-level, low-level, transuranic, and industrial wastes from the demonstration and testing of new spent fuel management processes from 1996 through 2024.

Experimental Breeder Reactor-II Blanket Treatment will also generate high-level, mixed low-level, and transuranic wastes.

High-level waste would be immobilized after 2005, and may eventually be transported to a Federal high-level waste and spent nuclear fuel repository for disposal. Transuranic waste meeting waste acceptance criteria to be developed could be shipped to a potential Federal repository for disposal should one be selected (EG&G 1993a).

5.14.4 Alternative 4a - Regionalization by Fuel Type

In general, the character of the impacts to materials and waste management would be similar to those under Alternative 3.

5.14.5 Alternative 4b(1) - Regionalization by Geography (INEL)

The character and intensity of impacts on waste management activities at the INEL are similar to those under Alternatives 3 and 4a for some of the SNF management projects including the TAN Pool Fuel Transfer Project at the Idaho Chemical Processing Plant; the Increased Rack Capacity and Additional Increased Rack Capacity projects; the Experimental Breeder Reactor-II Blanket Treatment facility; and the Electrometallurgical Process Demonstration Project. Under Alternative 4b(1), the Dry Fuel Storage Facility is expanded and Fuel Receiving, Canning/Characterization, and Shipping Facility waste streams decrease relative to Alternatives 3 and 4a; however, the net effect of these differences on industrial/commercial solid waste generation and low-level waste generation for both construction and operation results in waste generation rates similar to those under Alternatives 3 and 4a.

The increase in average and peak generation rates over Alternatives 3 and 4a (Tables 5.14-1 and 5.14-2) is due to the Spent Fuel Processing option included under Alternative 4b(1), which accounts for the relative increase in generation rates over Alternatives 3 and 4a. Fuel processing would be done in order to stabilize the spent nuclear fuel and remove risks associated with storage and disposal, and to manage the resultant high-level waste in a cost-effective manner. If this alternative were pursued aggressively, the generated high-level waste residual resulting from segregating fissile material from the spent nuclear fuel may require additional high-level waste tankage. This increase in capacity would be covered by the High-Level Tank Farm New Tanks project described in Volume 2 of the EIS.

Capacity discussions for industrial/commercial solid waste and low-level waste under Alternative 3 apply to Alternative 4b(1).

5.14.6 Alternative 4b(2) - Regionalization by Geography (Elsewhere)

Construction phase activities would generate a cumulative total of 50 cubic meters of industrial and commercial solid waste. Overall, waste generation would be lower than all of the SNF management alternatives, with the exceptions of the No Action and Decentralization Alternatives.

5.14.7 Alternative 5a - Centralization at Other DOE Sites

In general, the character of the impacts to materials and waste management would be similar to those under Alternative 4b(2).

5.14.8 Alternative 5b - Centralization at the INEL

In general, the character of the impacts to materials and waste management would be similar to those under Alternative 4b(1).

5.15 Accidents

5.15.1 Introduction

Activities associated with the transportation, receipt, handling, stabilization, and storage of spent nuclear fuel at the INEL involve substantial quantities of radioactive materials and limited quantities of toxic chemicals. Under certain circumstances, the potential exists for accidents involving these materials to occur, which would result in exposure to INEL workers or members of the public, or contamination of the surrounding environment. Accidents can be categorized as follows:

- Abnormal events such as minor spills
- Design-basis events, which a facility is designed to withstand
- Beyond-design-basis events, which a facility is not designed to withstand (but whose consequences it may nevertheless mitigate)

This section summarizes postulated radiological and toxic material accidents in each accident category and describes their estimated consequences to workers, members of the public, and the environment. The scope of this section is limited to accidents within facilities; transportation accidents between facilities are addressed in Section 5.11. [Further information on the accidents summarized in this section, as well as information on other "lower consequence" accidents analyzed, is provided in Slaughterbeck et al. (1995)].

An accident is a series of unexpected or undesirable "initiating" events that lead to a release of radioactive or toxic materials within a facility or to the environment. This analysis defines initiating events that can lead to a spent nuclear fuel-related facility accident in three broad categories: external initiators, internal initiators, and natural phenomena initiators. External initiators (e.g., aircraft crashes, and nearby explosions or toxic material releases) originate outside the facility and can affect the ability of the facility to maintain confinement of radioactive or hazardous material. Internal initiators originate within a facility (e.g., equipment failures or human error) and are usually the result of facility operation. Sabotage and terrorist activities (i.e., intentional human initiators) might be either external or internal initiators. Natural phenomena initiators include weather-related (e.g., floods and tornadoes) and seismic events. This analysis defines initiators in terms of events that cause, directly or indirectly,

a release of radioactive or hazardous materials within a facility or to the environment by failure or bypass of confinement.

Tables 5.15-1 through 5.15-4 summarize the radiological results of the analyses described in this section. Section 5.15.2 summarizes historic accidents at the INEL associated with spent nuclear fuel-related activities. Section 5.15.3 describes the methodology used to identify and evaluate potential radiological accidents associated with spent nuclear fuel receipt, handling, storage, and intra-area transportation activities. Sections 5.15.4 and 5.15.5 evaluate the postulated maximum reasonably foreseeable radiological and toxic material accidents, respectively.

5.15.2 Historic Perspective

Many of the actions proposed under the different spent nuclear fuel management alternatives considered in this EIS are continuations or variations of past practices at the INEL. DOE has analyzed consequences to the public from historic INEL accidents in detail and has determined them to be low (DOE 1991).

Consequences of accidents can involve fatalities, injuries, or illness. Fatalities can be prompt (immediate), such as in construction accidents, or latent (delayed), such as cancer caused by radiation exposure. While public comments received in scoping meetings for this EIS included many concerns about potential accidents at the INEL, the historic record demonstrates that DOE facilities, including the INEL, have a very good safety record, particularly in comparison to commercial industries (e.g., agriculture and construction). Figure 5.15-1 shows the rate of worker fatalities at the INEL and other DOE sites (DOE 1993b) compared to national-average rates that the National Safety Council compiled over a 10-year period for various industry groups (NSC 1993) and State of Idaho average rates (Hendrix 1994). While past accident occurrence rates are not necessarily indicative of future rates, the historic record reflects the DOE emphasis on safe operations.

There have been no prompt fatalities and no known latent fatalities to members of the public from accidental releases of radioactive or hazardous materials associated with spent nuclear fuel management activities in the 40-year history of INEL facilities, although some accidents associated

Table 5.15-1. Summary of radiological accidents for worker located 100 meters downwind from the point of release.

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[b]	Consequences[c]	(d)	(d)	(d)	(d)	(d)	(d)
	Adjusted annual frequency	1.0×10^{-2}	1.2×10^{-2}	3.1×10^{-2}	4.8×10^{-2}	8.6×10^{-2}	2.0×10^{-1}
	Adjusted point estimate of risk[e]	(d)	(d)	(d)	(d)	(d)	(d)
2. Uncontrolled chain reaction (criticality) at ICPP[f]	Consequences[c]	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}
	Adjusted annual frequency	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}
	Adjusted point estimate of risk[e]	4.0×10^{-8}	4.0×10^{-8}	4.0×10^{-8}	4.0×10^{-8}	4.0×10^{-8}	4.0×10^{-8}
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	Consequences[c]	2.5×10^{-4}	2.5×10^{-4}	2.5×10^{-4}	2.5×10^{-4}	2.5×10^{-4}	2.5×10^{-4}
	Adjusted annual frequency	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}
	Adjusted point estimate of risk[e]	2.5×10^{-9}	2.5×10^{-9}	2.5×10^{-9}	2.5×10^{-9}	2.5×10^{-9}	2.5×10^{-9}
4. Material release from HFEF resulting from aircraft crash and ensuing fire	Consequences[c]	1.8×10^{-3}	1.8×10^{-3}	1.8×10^{-3}	1.8×10^{-3}	1.8×10^{-3}	1.8×10^{-3}
	Adjusted annual frequency	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]
	Adjusted point estimate of risk[e]	1.8×10^{-10}	1.8×10^{-10}	1.8×10^{-10}	1.8×10^{-10}	1.8×10^{-10}	1.8×10^{-10}
5. Inadvertent nuclear criticality at ICPP[f] CPP-666 during processing	Consequences[c]	(h)	(h)	(h)	(h)	(h)	3.6×10^{-3}
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	1.0×10^{-3}
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	3.6×10^{-6}
6. Hydrogen explosion in ICPP[f] CPP-666 dissolver	Consequences[c]	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	(d)

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Table 5.15-1. (continued).

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
7. Inadvertent dissolution of 30-day cooled fuel at ICPP[f] CPP-666	Consequences[c]	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	(d)

a. The radiological accident results for Alternative 4b(1), "Regionalization by Geography (INEL)," are conservatively assumed to be the same as those presented for Alternative 5b, as discussed in Section 5.15.4.4. The radiological accident results for Alternative 4b(2), "Regionalization by Geography (Elsewhere)," are identical to those presented for Alternative 5a, as discussed in Section 5.15.4.4.

b. HFEF = Hot Fuel Examination Facility.

c. Consequences are presented in terms of latent fatal cancers based on conservative (95 percentile) meteorological conditions. Consequences are calculated by multiplying the estimated exposure (i.e., dose) by an International Commission on Radiological Protection conversion factor of 4.0×10^{-4} cancer per rem for an adult worker (or 8.0×10^{-4} cancer per rem if the estimated exposure is greater than 20 rem).

d. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from Accident 1 could be less than the consequences from Accidents 2 through 4. However, given the high frequency for Accident 1 compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.

e. This attribute is equal to consequences × frequency (events per year). The information is based on conservative (95 percentile) meteorological conditions.

f. ICPP = Idaho Chemical Processing Plant.

g. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

h. Resuming processing at the INEL under this alternative is not considered.

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Table 5.15-2. Summary of radiological accidents for individual located at the nearest point of public access within the site boundary.

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[b]	Consequences[c]	(d)	(d)	(d)	(d)	(d)	(d)
	Adjusted annual frequency	1.0×10^{-2}	1.2×10^{-2}	3.1×10^{-2}	4.8×10^{-2}	8.6×10^{-2}	2.0×10^{-1}
	Adjusted point estimate of risk[e]	(d)	(d)	(d)	(d)	(d)	(d)
2. Uncontrolled chain reaction (criticality) at ICPP[f]	Consequences[c]	7.0×10^{-7}	7.0×10^{-7}	7.0×10^{-7}	7.0×10^{-7}	7.0×10^{-7}	7.0×10^{-7}
	Adjusted annual frequency	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}
	Adjusted point estimate of risk[e]	7.0×10^{-10}	7.0×10^{-10}	7.0×10^{-10}	7.0×10^{-10}	7.0×10^{-10}	7.0×10^{-10}
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	Consequences[c]	3.3×10^{-4}	3.3×10^{-4}	3.3×10^{-4}	3.3×10^{-4}	3.3×10^{-4}	3.3×10^{-4}
	Adjusted annual frequency	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}
	Adjusted point estimate of risk[e]	3.3×10^{-9}	3.3×10^{-9}	3.3×10^{-9}	3.3×10^{-9}	3.3×10^{-9}	3.3×10^{-9}
4. Material release from HFEF resulting from aircraft crash and ensuing fire	Consequences[c]	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}
	Adjusted annual frequency	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]
	Adjusted point estimate of risk[e]	1.6×10^{-11}	1.6×10^{-11}	1.6×10^{-11}	1.6×10^{-11}	1.6×10^{-11}	1.6×10^{-11}
5. Inadvertent nuclear criticality ICPP[f] CPP-666 during processing	Consequences[c]	(h)	(h)	(h)	(h)	(h)	2.5×10^{-5}
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	1.0×10^{-3}
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	2.5×10^{-8}
6. Hydrogen explosion in ICPP[f] CPP-666 dissolver	Consequences[c]	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	(d)

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Table 5.15-2. (continued).

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
7. Inadvertent dissolution of 30-day cooled fuel at ICPP[f] CPP-666	Consequences[c]	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	(d)
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	(d)

a. The radiological accident results for Alternative 4b(1), "Regionalization by Geography (INEL)," are conservatively assumed to be the same as those presented for Alternative 5b, as discussed in Section 5.15.4.4. The radiological accident results for Alternative 4b(2), "Regionalization by Geography (Elsewhere)," are identical to those presented for Alternative 5a, as discussed in Section 5.15.4.4.

b. HFEF = Hot Fuel Examination Facility.

c. Consequences are presented in terms of latent fatal cancers based on conservative (95 percentile) meteorological conditions. Consequences are calculated by multiplying the estimated exposure (i.e., dose) by an International Commission on Radiological Protection conversion factor of 5.0×10^{-4} cancer per person-rem for the offsite population (or 1.0×10^{-3} cancer per rem if the estimated population exposure is greater than 20 rem for any individual member of the public).

d. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4. However, given the high frequency for this accident compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.

e. This attribute is equal to consequences × frequency (events per year). The information is based on conservative (95 percentile) meteorological conditions.

f. ICPP = Idaho Chemical Processing Plant.

g. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

h. Resuming processing at the INEL under this alternative is not considered.

Table 5.15-3. Summary of radiological accidents for maximally exposed hypothetical individual located at the nearest site boundary.

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[b]	Consequences[c]	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
	Adjusted annual frequency	1.0×10^{-2}	1.2×10^{-2}	3.1×10^{-2}	4.8×10^{-2}	8.6×10^{-2}	2.0×10^{-1}
	Adjusted point estimate of risk[d]	1.0×10^{-8}	1.2×10^{-8}	3.1×10^{-8}	4.8×10^{-8}	8.6×10^{-8}	2.0×10^{-7}
2. Uncontrolled chain reaction (criticality) at ICPP[e]	Consequences[c]	5.0×10^{-7}	5.0×10^{-7}	5.0×10^{-7}	5.0×10^{-7}	5.0×10^{-7}	5.0×10^{-7}
	Adjusted annual frequency	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}
	Adjusted point estimate of risk[d]	5.0×10^{-10}	5.0×10^{-10}	5.0×10^{-10}	5.0×10^{-10}	5.0×10^{-10}	5.0×10^{-10}
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	Consequences[c]	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}
	Adjusted annual frequency	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}
	Adjusted point estimate of risk[d]	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}
4. Material release from HFEF resulting from aircraft crash and ensuing fire	Consequences[c]	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}
	Adjusted annual frequency	1.0×10^{-7}[f]	1.0×10^{-7}[f]	1.0×10^{-7}[f]	1.0×10^{-7}[f]	1.0×10^{-7}[f]	1.0×10^{-7}[f]
	Adjusted point estimate of risk[d]	2.5×10^{-10}	2.5×10^{-10}	2.5×10^{-10}	2.5×10^{-10}	2.5×10^{-10}	2.5×10^{-10}
5. Inadvertent nuclear criticality ICPP[e] CPP-666 during processing	Consequences[c]	(g)	(g)	(g)	(g)	(g)	1.4×10^{-5}
	Adjusted annual frequency	(g)	(g)	(g)	(g)	(g)	1.0×10^{-3}
	Adjusted point estimate of risk[d]	(g)	(g)	(g)	(g)	(g)	1.4×10^{-8}
6. Hydrogen explosion in ICPP[e] CPP-666 dissolver	Consequences[c]	(g)	(g)	(g)	(g)	(g)	3.2×10^{-7}
	Adjusted annual frequency	(g)	(g)	(g)	(g)	(g)	1.0×10^{-5}
	Adjusted point estimate of risk[d]	(g)	(g)	(g)	(g)	(g)	3.2×10^{-12}

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Table 5.15-3. (continued).

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
7. Inadvertent dissolution of 30-day cooled fuel at ICPP[e] CPP-666	Consequences[c]	(g)	(g)	(g)	(g)	(g)	1.5×10^{-5}
	Adjusted annual frequency	(g)	(g)	(g)	(g)	(g)	1.0×10^{-6}
	Adjusted point estimate of risk[d]	(g)	(g)	(g)	(g)	(g)	1.5×10^{-11}

a. The radiological accident results for Alternative 4b(1), "Regionalization by Geography (INEL)," are conservatively assumed to be the same as those presented for Alternative 5b, as discussed in Section 5.15.4.4. The radiological accident results for Alternative 4b(2), "Regionalization by Geography (Elsewhere)," are identical to those presented for Alternative 5a, as discussed in Section 5.15.4.4.

b. HFEF = Hot Fuel Examination Facility.

c. Consequences are presented in terms of latent fatal cancers based on conservative (95 percentile) meteorological conditions. Consequences are calculated by multiplying the estimated exposure (i.e., dose) by an International Commission on Radiological Protection conversion factor of 5.0×10^{-4} cancer per person-rem for the offsite population (or 1.0×10^{-3} cancer per rem if the estimated population exposure is greater than 20 rem for any individual member of the public).

d. This is equal to consequences × frequency (events per year). The information is based on conservative (95 percentile) meteorological conditions.

e. ICPP = Idaho Chemical Processing Plant.

f. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

g. Resuming processing at the INEL under this alternative is not considered.

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Table 5.15-4. Summary of radiological accidents for offsite population within 80 kilometers (50 miles) from the point of release.

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[b]	Consequences[c]	(d)	(d)	(d)	(d)	(d)	(d)
	Adjusted annual frequency	1.0×10^{-2}	1.2×10^{-2}	3.1×10^{-2}	4.8×10^{-2}	8.6×10^{-2}	2.0×10^{-1}
	Adjusted point estimate of risk[e]	(d)	(d)	(d)	(d)	(d)	(d)
2. Uncontrolled chain reaction (criticality) at ICPP[f]	Consequences[c]	3.0×10^{-4}	3.0×10^{-4}	3.0×10^{-4}	3.0×10^{-4}	3.0×10^{-4}	3.0×10^{-4}
	Adjusted annual frequency	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}
	Adjusted point estimate of risk[e]	3.0×10^{-7}	3.0×10^{-7}	3.0×10^{-7}	3.0×10^{-7}	3.0×10^{-7}	3.0×10^{-7}
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	Consequences[c]	7.0×10^{0}	7.0×10^{0}	7.0×10^{0}	7.0×10^{0}	7.0×10^{0}	7.0×10^{0}
	Adjusted annual frequency	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}
	Adjusted point estimate of risk[e]	7.0×10^{-5}	7.0×10^{-5}	7.0×10^{-5}	7.0×10^{-5}	7.0×10^{-5}	7.0×10^{-5}
4. Material release from HFEF resulting from aircraft crash and ensuing fire	Consequences[c]	1.0×10^{0}	1.0×10^{0}	1.0×10^{0}	1.0×10^{0}	1.0×10^{0}	1.0×10^{0}
	Adjusted annual frequency	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]	1.0×10^{-7}[g]
	Adjusted point estimate of risk[e]	1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-7}
5. Inadvertent nuclear criticality ICPP[f] CPP-666 during processing	Consequences[c]	(h)	(h)	(h)	(h)	(h)	2.8×10^{-3}
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	1.0×10^{-3}
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	2.8×10^{-6}
6. Hydrogen explosion in ICPP[f] CPP-666 dissolver	Consequences[c]	(h)	(h)	(h)	(h)	(h)	4.1×10^{-4}
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	1.0×10^{-5}
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	4.1×10^{-9}

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Table 5.15-4. (continued).

Accident Description	Attribute	Alternative 1 No Action	Alternative 2 Decentralization	Alternative 3 1992/1993 Planning Basis	Alternative 4a[a] Regionalization by Fuel Type	Alternative 5a Centralization at Other Sites	Alternative 5b Centralization at the INEL
7. Inadvertent dissolution of 30-day cooled fuel at ICPP[f] CPP-666	Consequences[c]	(h)	(h)	(h)	(h)	(h)	1.5×10^{-2}
	Adjusted annual frequency	(h)	(h)	(h)	(h)	(h)	1.0×10^{-6}
	Adjusted point estimate of risk[e]	(h)	(h)	(h)	(h)	(h)	1.5×10^{-8}

a. The radiological accident results for Alternative 4b(1), "Regionalization by Geography (INEL)," are conservatively assumed to be the same as those presented for Alternative 5b, as discussed in Section 5.15.4.4. The radiological accident results for Alternative 4b(2), "Regionalization by Geography (Elsewhere)," are identical to those presented for Alternative 5a, as discussed in Section 5.15.4.4.

b. HFEF = Hot Fuel Examination Facility.

c. Consequences are presented in terms of latent fatal cancers based on conservative (95 percentile) meteorological conditions. Consequences are calculated by multiplying the estimated exposure (i.e., dose) by an International Commission on Radiological Protection conversion factor of 5.0×10^{-4} cancer per person-rem for the offsite population (or 1.0×10^{-3} cancer per rem if the estimated population exposure is greater than 20 rem for any individual member of the public).

d. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4. However, given the high frequency for this accident compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.

e. This attribute is equal to consequences × frequency (events per year). The information is based on conservative (95 percentile) meteorological conditions.

f. ICPP = Idaho Chemical Processing Plant.

g. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

h. Resuming processing at the INEL under this alternative is not considered.

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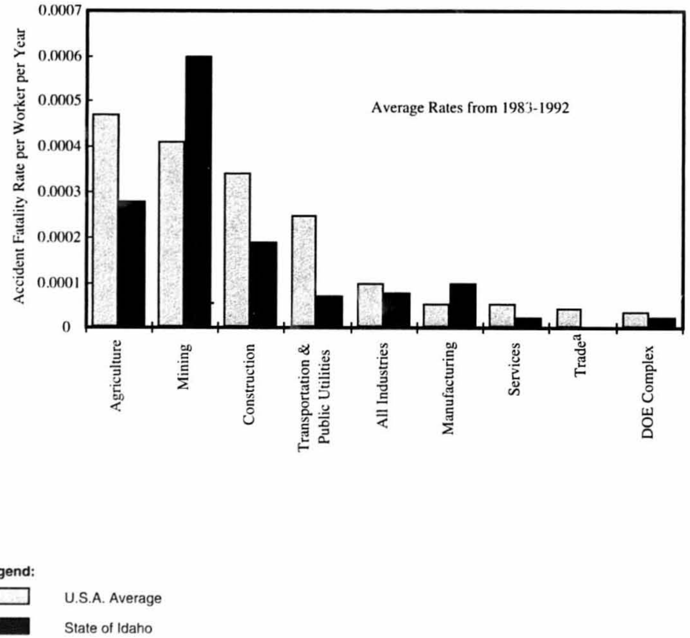

a. Datum for State of Idaho is unavailable.

Sources: NSC (1993); DOE (1993b) and Hendrix (1994)

PJ20-1

Figure 5.15-1. Comparison of fatality rates among workers in various industry groups.

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with spent nuclear fuel management activities have occurred. In 1958, filters in the Idaho Chemical Processing Plant CPP-601 Fuel Element Cutting Facility failed during decontamination operations. An estimated 100 curies of particulate radioactivity were released over an area of approximately 200 acres (0.809 square kilometers) in the vicinity of the Idaho Chemical Processing Plant. Approximately 39 curies became airborne, resulting in an estimated dose of 0.11 millirem to a hypothetical offsite individual located at the nearest site boundary (DOE 1991).

Three inadvertent nuclear chain reactions (i.e., nuclear criticalities) occurred at the Idaho Chemical Processing Plant in 1959, 1961, and 1978. The 1959 criticality occurred in a process waste and cell floor drain collection tank. Available evidence indicates that the critical solution resulted from an accidental transfer of concentrated uranyl nitrate solution to the waste collection tank through a line normally used to transfer decontaminating solutions to the waste tank. The estimated airborne release from this incident was 3,700 curies, and the estimated dose to the maximally exposed hypothetical individual located at the nearest site boundary was 1.1 millirem (DOE 1991). The 1961 and 1978 nuclear criticalities resulted from spent nuclear fuel dissolution and reprocessing activities. Estimated releases to the environment as a result of these accidents were 120 curies and 620 curies for the 1961 and 1978 accidents, respectively, and the calculated radiation doses at the nearest site boundary were less than 0.1 millirem for both releases (DOE 1991).

The INEL Fluorinel and Storage (FAST) facility (CPP-666), which historically performed spent nuclear fuel-related reprocessing activities, is currently shut down. Activities are under way to place this facility in a permanent shutdown mode. Restart of this facility and the potential for an inadvertent nuclear criticality resulting from operating this facility are considered in Sections 5.15.4.4 and 5.15.4.5 [Alternatives 4b(1) and 5b, respectively]. Because DOE has no current plans to resume spent nuclear fuel reprocessing activities at the Idaho Chemical Processing Plant, events similar to the three historic nuclear criticalities discussed above will be unlikely in future INEL spent nuclear fuel-related activities. Additional information regarding the historical accidents summarized above is provided in Slaughterbeck et al. (1995).

In the site's 40-year history, three prompt fatalities of INEL workers have occurred by accidents involving radiation exposure. In 1961, a steam explosion resulting from an unplanned nuclear criticality in an experimental reactor (Stationary Low-Power Reactor No. 1) killed these workers, who were manually moving reactor control elements. The estimated dose from this accident to a hypothetical individual located at the nearest site boundary was approximately 3 millirem (DOE 1991). All the accidents discussed above have caused contamination that has led to secondary impacts, such as the contamination of facility equipment and land inside the site boundary, and have required cleanup.

Twenty workers at the Argonne National Laboratory-West facility area were injured in early 1994 when, in an accident involving toxic material exposure, approximately 9 kilograms (20 pounds) of chlorine gas used to treat potable (i.e., drinking) water were accidently released to the environment. Although an investigation into this incident by the DOE was still ongoing at the time this analysis was performed, the accident is presumed to have occurred while a vendor was removing and replacing a nearly empty chlorine cylinder. A maintenance employee assisting in the activity apparently disconnected the nearly empty in-service chlorine gas cylinder from the potable water system with the cylinder valve in the open position, resulting in the remaining tank contents being discharged to the environment. As a result of the accidental release, 20 workers were sent to a local hospital. Eighteen workers reported for treatment of minor respiratory distress, one worker reported symptoms of more serious respiratory problems, and one worker reported back injuries as a result of falling while responding to the accident. (ANL 1994 and DOE 1994b).

5.15.3 Methodology for Determining the Maximum Reasonably Foreseeable Radiological Accidents

5.15.3.1 Selection of Spent Nuclear Fuel Facilities and Operations Requiring Accident Analyses. The accident analyses performed to support this EIS considered all INEL nonreactor nuclear facilities that support spent nuclear fuel-related activities with the exception of those at the Naval Reactors Facility (NRF) area. Appendix D of this EIS discusses each of the spent nuclear fuel management alternatives and postulated accident scenarios associated with the Naval Reactors Facility and other naval spent nuclear fuel facilities.

DOE Order 5480.23 (DOE 1992a) defines nonreactor nuclear facilities as those activities or operations that involve radioactive or fissionable materials in such form and quantity that a nuclear hazard potentially exists to the workers or the general public. This analysis considered spent nuclear fuel facilities designed and constructed as direct support to reactor facilities (e.g., Advanced Test Reactor Storage Canal, which stores spent nuclear fuel and irradiated fuels) as nonreactor spent nuclear fuel facilities.

DOE manages spent nuclear fuel at the following INEL facility areas: Idaho Chemical Processing Plant, Naval Reactors Facility, Test Reactor Area, Auxiliary Reactor Area/Power Burst Facility, Argonne National Laboratory-West, and Test Area North. For further information regarding

the activities conducted in these areas, refer to Chapter 2. After identifying all the nonreactor nuclear facilities within these facility areas that stabilize, handle, or store spent nuclear fuel, this analysis ranked the facilities according to potential hazards using preexisting facility "hazard classifications." DOE Order 5480.23 requires contractors operating nonreactor nuclear facilities to perform a hazard classification of a facility to assess the consequences of an unmitigated release of radioactive or hazardous material in one of the following categories[1]:

- Category 1. The hazard analysis shows the potential for significant offsite consequences.
- Category 2. The hazard analysis shows the potential for significant onsite consequences.
- Category 3. The hazard analysis shows the potential for only significant localized consequences.

The classification of nonreactor nuclear facilities in one of these three categories was in accordance with DOE Standard DOE-STD-1027-92 (DOE 1992b). This standard provides guidance for the hazard categorization of nuclear facilities based on facility inventories of radionuclides and the potential for those radionuclides to affect workers or the public if released to the environment.

This analysis used these categories as a screening threshold to identify those facilities of interest (i.e., those spent nuclear fuel-related facilities with sufficient quantities of radionuclides to present the potential for significant impacts to workers or the public if released to the environment). The analysis excluded (screened out) Category 3 (low hazard) facilities if they present possible worker consequences enveloped by postulated accidents at Category 2 facilities. Facilities with a hazard classification of 2 or greater (or Category 3 facilities that were not screened out) were evaluated further, as discussed in the next section.

5.15.3.2 Determination of Maximum Reasonably Foreseeable Radiological Accidents. After determining spent nuclear fuel-related facilities with sufficient quantities of radionuclides to present radiological consequences to workers or the public (as discussed in

1 These categories were formerly labeled "high," "moderate," and "low" in accordance with DOE Order 5481.1B (DOE 1987), which has been superseded by DOE Order 5480.23 for nonreactor nuclear facilities.

Section 5.15.3.1), the analysis generated potential accident scenarios for each of these INEL facilities by performing the following activities:

- Reviewing historic spent nuclear fuel-related accidents that have occurred during the 40-year history of the INEL.

- Reviewing existing accident analyses and safety analysis reports for spent nuclear fuel-related activities and facilities.

- Identifying potential internal, external, and natural phenomena events that could initiate spent nuclear fuel-related accidents other than those previously analyzed.

- Performing additional accident analyses for those accidents considered to present the greatest consequences to workers or the public, as necessary.

The analysis considered internal and external initiators associated with a wide range of activities (e.g., research and development and construction or modification of facilities) not necessarily covered in existing safety analyses. For example, potential radiological accident scenarios initiated by construction activities associated with constructing new spent nuclear fuel-related facilities or modifying existing spent nuclear fuel-related facilities (as proposed under the various alternatives) were postulated. Typically, events involved in the construction of new spent nuclear fuel-related facilities would act as external initiators to existing facilities, while events involved in modifying existing spent nuclear fuel facilities would act as internal initiators. Examples of construction or industrial-type events that could initiate a radiological accident included fires, confinement impacts or puncture events, equipment failure, and human error.

Additional considerations used to determine potential internal and external initiators that could lead to spent nuclear fuel-related radiological accidents included vulnerabilities associated with handling, stabilizing, and storing severely degraded spent nuclear fuel and equipment. For example, in November 1993, DOE issued a report (DOE 1993c) discussing vulnerabilities associated with various spent nuclear fuel-related facilities across the DOE complex. The report identified one INEL facility, the CPP-603 Underwater Fuel Storage Facility, as requiring immediate management attention to avoid unnecessary increases in worker exposures, cleanup costs, and postulated accident frequencies. Activities have begun to stabilize spent nuclear fuel inventories in the CPP-603 facility and relocate them to another facility (CPP-666); these activities will continue for several years after the scheduled

1995 Record of Decision for this EIS. Therefore, the analysis considered postulated accident scenarios associated with stabilizing and relocating CPP-603 spent nuclear fuel inventories to be potential accident initiators in developing the radiological accidents summarized in this EIS. Examples of accident scenarios considered as a result of degraded spent nuclear fuel or facility equipment included inadvertent nuclear criticalities, physical damage of spent nuclear fuel and spent nuclear fuel facilities, and radionuclide releases resulting from handling and stabilizing degraded spent nuclear fuel. For postulated accident scenarios at facilities other than the CPP-603 Underwater Fuel Storage Facility, the analysis also considered the potential for long-term degradation of facility structures, equipment, and spent nuclear fuel inventories that could lead to an increased probability for radiological accidents.

To compare the various possible spent nuclear fuel-related accident scenarios and to identify those maximum reasonably foreseeable accidents that present the greatest consequences to workers and the public, the analysis divided each postulated spent nuclear fuel-related accident into the appropriate frequency category (abnormal events, design-basis accidents[2], or beyond-design-basis accidents), according to its estimated frequency of occurrence. Table 5.15-5 lists the frequency ranges associated with the abnormal event, design-basis accident, and beyond-design-basis accident categories discussed in Section 5.15.1.

The estimated frequency of each postulated accident was based on an identification of the physical basis for the accident and the events required for the accident to occur. Because many of the postulated accidents or their constituent events (initiators or precursors) have rarely or never occurred, frequency data based on historic experience were not available. Therefore, in many instances, it was necessary to develop a frequency estimate on the basis of events for which experience existed and engineering judgment. More than 40 sources of frequency data for the accident events postulated were reviewed, including analyses and reports prepared for the DOE, U.S. Nuclear Regulatory Commission (NRC), Electric Power Research Institute, and private industry. [For further information regarding the development of estimated accident frequencies, refer to Slaughterbeck et al. (1995).]

After the division of the postulated spent nuclear fuel-related accidents into the frequency ranges defined in Table 5.15-5, the analysis identified the postulated nonprocessing-related accident within each frequency range determined to present the maximum offsite consequences as a maximum

2 For facilities where design-basis accident analyses were unavailable, evaluation basis accident scenarios (postulated accident scenarios used where documented design basis accident analyses do not exist) were considered in accordance with DOE-DP-STD-3005-YR (DOE 1994a).

Table 5.15-5. Accident frequency categories.

Frequency Category	Accident Frequency Range (accidents per year)
Abnormal events	frequency $\geq 1\times10^{-3}$ per year
Design-basis accidents	1×10^{-3} per year > frequency $\geq 1\times10^{-6}$ per year
Beyond-design-basis accidents	1×10^{-6} per year > frequency $\geq 1\times10^{-7}$ per year

reasonably foreseeable radiological accident to be further analyzed for this EIS. Potential nonprocessing-related accident scenarios were chosen as maximum reasonably foreseeable accidents because of the shutdown status of the INEL facility (CPP-666) that historically processed spent nuclear fuel. However, because existing inventories of spent nuclear fuel at the INEL would substantially increase under Alternatives 4b(1) and 5b [Regionalization by Geography (INEL) and Centralization at the INEL, respectively], there could be a need to resume processing operations to stabilize degraded spent nuclear fuel operations and assure adequate storage space for spent nuclear fuel received from other sites.[3] Therefore, in addition to the maximum reasonably foreseeable nonprocessing-related accident scenarios, this analysis considers the three postulated processing-related accidents that present the maximum offsite consequences as additional maximum reasonably foreseeable accidents under Alternatives 4b(1) and 5b.

In addition, a postulated inadvertent nuclear criticality accident at the CPP-603 Underwater Storage Facility was considered for further analysis because significant vulnerabilities associated with its spent nuclear fuel inventories have been identified (DOE 1993b) and postulated criticality accidents have been addressed in virtually all nonreactor DOE EISs and safety analysis reports where the accidents are reasonably foreseeable because of public concerns regarding their potential. As a result, the seven radiological accidents summarized in Section 5.15.4 were determined to be the maximum reasonably foreseeable radiological accidents (i.e., greatest consequences). Further discussion and analysis information for each of these accidents, as well as other accidents analyzed, is provided in Slaughterbeck et al. (1995). Appendix D identifies maximum reasonably foreseeable accidents associated with transporting, receiving, handling, and storing naval spent nuclear fuel at the INEL. The postulated accidents summarized in this section considered with the INEL facilities analyzed in

3 Processing would be performed in the Fluorinel and Storage (FAST) facility (CPP-666) and a new facility to be constructed, the Fuel Processing Restoration (FPR) facility (CPP-691). Processing would consist of dissolving spent nuclear fuel to immobilize radionuclides for final waste disposal.

Appendix D provide a basis for characterizing the potential risks and consequences associated with managing spent nuclear fuel at the INEL over the next 40 years.

Seismic events were the only identified common-cause initiators with the potential to initiate radioactive material releases to the environment at more than one spent nuclear fuel-related facility at the INEL. However, a seismic event resulting in significant damage and radioactive releases from facilities in more than one facility area (e.g., Idaho Chemical Processing Plant and Test Area North) is considered beyond reasonably foreseeable (frequency less than one in ten million years), because of the physical distance and isolation between facility areas. In accordance with DOE guidance (DOE 1994a), a seismic event initiating multiple-facility releases in more than one facility area on the site was screened from further consideration because of its extremely low frequency of occurrence.

Analyses were performed that evaluated the potential consequences and risks associated with multiple-facility releases within a single INEL facility area resulting from a severe seismic event (Slaughterbeck et al. 1995). For example, within a 500-meter radius in the Idaho Chemical Processing Plant facility area, there are several spent nuclear fuel facilities, the primary facilities being the CPP-749 dry storage facilities and the CPP-666 and CPP-603 underwater fuel storage facilities. An analysis was performed (Slaughterbeck et al. 1995) to determine whether simultaneous releases from these facilities could result from a severe seismic event. Because the CPP-666 and CPP-749 facilities were designed and qualified to withstand a severe seismic event, they are not expected to contribute to the consequences and risks resulting from a severe seismic event impacting the Idaho Chemical Processing Plant. However, because of known structural deficiencies and vulnerabilities with the spent nuclear fuel at the CPP-603 facility, the CPP-603 facility is expected to be significantly damaged following a severe seismic event, resulting in one or more criticalities and the leakage of contaminated basin water to the surrounding environment. While the consequences from these simultaneous multiple-release mechanisms (one or more criticalities and water drainage) would be greater than the single criticality analyzed for CPP-603 facility (Section 5.15.3.3.2), the consequences and risk of such releases are expected to be bounded by the other accidents analyzed in the EIS--primarily, a seismic event that causes fuel melting at the Argonne National Laboratory-West Hot Fuel Examination Facility (highest consequence accident), and a fuel handling accident in the same facility (highest risk accident, where risk = consequence x frequency). Similar analyses (DOE 1993a) for the Test Area North and Argonne National Laboratory-West also demonstrate that potential multiple-facility releases or multiple-release mechanisms from a single facility resulting from a severe seismic event would also be bounded by accidents postulated for the Hot Fuel Examination Facility. Based on this conclusion and the accident selection methodology described 5.15.3.1, the consequences and risks associated with multiple-facility releases were screened from further consideration since they do not represent the bounding accident scenarios within the frequency categories defined in Table 5.15-5.

In addition, the screening methodology did not specifically include potential accident scenarios associated with operating new spent nuclear fuel handling and storage facilities proposed under the various alternatives considered in this EIS because postulated accident scenarios for existing facilities would bound the consequences associated with potential accidents at new facilities. This assumption is appropriate for two primary reasons. First, the missions of new spent nuclear fuel facilities would be similar to the missions of existing spent nuclear fuel-related DOE facilities, which implies that DOE would consider the same types of accident scenarios for the new facilities it considered for the existing facilities. Second, DOE would design and build new facilities that would incorporate modern preventive and mitigative features to reduce the frequency and potential consequences associated with postulated accidents.

To compare the consequences of the same accident scenario at an identical hypothetical facility constructed at each DOE site included in this EIS (based on local geological and meteorological conditions), Appendix D summarizes postulated accident scenarios for a new Expended Core Facility at Oak Ridge, Hanford Site, Savannah River Site, or Nevada Test Site.

To determine the radiological and toxicological consequences presented throughout Section 5.15 associated with the postulated accidents and with spent nuclear fuel-related activities, the analysis used the following definitions:

- Worker. An individual 100 meters (328 feet) downwind of the facility location where the release occurs.[4]

- Nearest Public Access. The nearest point of public access to the location where the release occurs, sometimes inside the site boundary.

4 The worker is defined as the individual located at 100 meters because reliable safety analyses quantifying the impacts (e.g., dose and health effects) to workers at distances less than 100 (i.e., "close-in" workers) meters from an accidental release of radionuclides are unavailable. The effects on and risks to workers closer in than 100 meters are recognized and discussed in Section 5.15.3.3. Each of the maximum reasonably foreseeable accidents considered in this EIS, particularly the design-basis and beyond-design-basis accidents, contains some risk of worker injury or death at distances closer than 100 meters.

- Maximally Exposed Offsite Individual. A hypothetical resident at the site boundary nearest to the facility where the release occurs.

- Offsite Population. The collective total of individuals within an 80-kilometer (50-mile) radius of the INEL.

- Environment. The area outward from 100 meters (328 feet) downwind of the facility where the release occurs.

5.15.3.3 Impact of Accidents on Close-In Workers. An evaluation has been made on the radiological impact to close-in workers from the selected accident scenarios. Injuries or fatalities that might occur due to an external event, such as a severe seismic disturbance or airplane crash into the structure, are not considered in this evaluation since they are not attributable to direct radiological consequences. Seven accident scenarios for nonprocessing-related and processing-related activities are considered maximum reasonably foreseeable accidents.

5.15.3.3.1 Mechanical Handling Accident at the Argonne National Laboratory West Hot Fuel Examination Facility — This accident is assumed to result in fuel pin breach and venting of noble gases and iodine. No fatalities to workers are expected from this event. However, a substantial iodine dose to the thyroid could cause radiation-induced hypothyroidism or a similar disorder.

5.15.3.3.2 Criticality Accident at the Idaho Chemical Processing Plant - CPP-603 — This event is an unplanned nuclear criticality associated with underwater spent nuclear fuel storage at the CPP-603 facility. Based on shielding provided by the pool water, it is likely that no fatalities would occur. To the extent water is expelled due to the energy of the event, close-in workers could receive substantial radiation exposure. Worker presence in the area above the pool or very close to the edge of the pool is not routine. The impact of the event would likely be isolated to nearby equipment operators if the criticality were initiated by a handling error.

5.15.3.3.3 Seismic Event Leading to Fuel Melt at the Argonne National Laboratory West Hot Fuel Examination Facility — A seismic event is postulated to result in a breech of the main cell used for examination of the fuel, which is assumed to lead to a failure of the fuel cooling system. It is likely that the release of radioactive materials from fuel melting would occur slowly enough to allow evacuation of all workers before any appreciable exposure. Therefore, no radiation-induced fatalities would be expected.

5.15.3.3.4 Airplane Crash and Fire at Argonne National Laboratory West Hot Fuel Examination Facility — An airplane crash and subsequent fire sustained by airplane fuel could result in a major breach of the confinement barriers and could lead to a substantial atmospheric release of radionuclides. Workers unaffected by the airplane crash or fire would not be expected to remain in the area long enough to receive substantial radiation exposure. It is assumed the buoyancy of the radioactive material due to the fire would mitigate the direct radiological impacts to close-in workers, substantially reducing the likelihood of radiation induced worker fatalities.

5.15.3.3.5 Criticality Accident During Processing at the Idaho Chemical Processing Plant - CPP-666 — This is the first of three evaluated accidents that could occur only if processing were resumed at the Fluorinel and Storage Facility (FAST). Three inadvertent nuclear criticalities have occurred in INEL processing facilities and none has resulted in worker fatalities. In each event, radioactive material was released to the atmosphere and close-in workers received direct exposure. If processing were resumed, the techniques and controls implemented to prevent recurrence of processing-related criticalities would be employed again. Due to the cell wall shielding provided by concrete walls that are several feet thick, it is expected that no workers would receive substantial radiation exposure.

5.15.3.3.6 Hydrogen Explosion at the Idaho Chemical Processing Plant — A hydrogen explosion in the dissolver off-gas system of the Flourinel and Storage (FAST) Facility would result in release of radioactive material to the facility. If workers were near the dissolver off-gas system, they could receive substantial radiation exposure from the explosion. No fatalities would be expected, but radiation-induced health detriments could occur.

5.15.3.3.7 Dissolution of Short-Cooled Fuel at the Idaho Chemical Processing Plant — An explosion in the dissolver tank could occur if fuel that has not cooled for at least 30 days was inadvertently shipped to the dissolver at the Flourinel and Storage Facility (FAST). This energetic event would likely breach the dissolver off gas system and could breach the dissolver tank. Workers in the areas closely associated with the dissolver tank could receive substantial radiation exposure, but it is likely that no radiation-induced fatalities would occur.

5.15.3.4 Analysis of Radiological Accident Consequences. The quantities of radioactive materials and the ways these materials interact with human beings are important factors in determining health effects. The ways in which radioactive materials reach human beings, their absorption and retention in the body, and the resulting health effects have been studied in great detail. The International Commission on Radiological Protection (ICRP) has made specific recommendations for quantifying these health effects (ICRP 1991). This organization is the recognized body for establishing standards for the protection of workers and the public from the effects of radiation exposure. Health effects can be classified into two categories: prompt (also referred to as acute) and latent. Prompt health effects are those experienced immediately after exposure and include damage to the body up to and including death. Latent health effects are those experienced some time after exposure and include cancers and hereditary symptoms. An INEL-developed computer code, Radiological Safety Analysis Computer Program-5 (RSAC-5), estimates potential radiation doses to maximally exposed individuals or population groups from accidental releases of radionuclides. This code, which is customized to specific INEL conditions, uses well-established and generally accepted scientific engineering principles as the basis for its various calculational steps. The code is based on guidance provided in NRC Guide 1.145 (NRC 1983) and has been validated to comply with accepted standards for such software. [For a detailed description of RSAC-5, refer to Slaughterbeck et al. (1995).]

The RSAC-5 code determined estimated consequences to the worker, an individual assumed to be stranded at the nearest point of public access, the maximally exposed hypothetical individual at the nearest site boundary, and the offsite population within 80 kilometers (50 miles) of the radiological accidents postulated under Alternative 1, No Action. Postulated frequencies and consequences analyzed under Alternative 1 are based on (1) the approximate amount of spent nuclear fuel currently at the INEL [measured in Metric Tons Heavy Metal (MTHM)], (2) the estimated increases in inventories resulting from spent nuclear fuel generated by operating INEL reactors (i.e., fuel recently removed from a reactor that has not had sufficient time to cool), and (3) the estimated number of fuel handling activities associated with stabilizing or relocating spent fuel inventories inside the INEL site boundary. Although the four nonprocessing-related maximum reasonably foreseeable radiological accident scenarios identified for Alternative 1 are also considered under Alternatives 2 through 5, proposed changes in INEL spent nuclear fuel inventories and the number of fuel handling activities associated with these changes could affect the estimated frequencies and consequences expected for Alternatives 2 through 5. Therefore, to reasonably estimate the frequencies and consequences associated with activities proposed under Alternatives 2 through 5, the frequencies and consequences for the accidents presented under Alternative 1 require appropriate "adjustment" or "scaling."

To be conservative, the analysis assumed that the increase in the annual frequency of mechanical handling accidents would be equal to the estimated increase in the annual number of handling events proposed under Alternatives 2 through 5. However, the consequences associated with a mechanical handling accident would not vary with a change in the number of handling events because the amount of material involved in each event would not change. To determine potential changes in annual mechanical handling accident frequencies between the different spent nuclear fuel management alternatives, the analysis based its estimates of the annual number of fuel handling events under each alternative on spent fuel shipment rates anticipated for the next 40 years, as discussed in Appendix I. Estimates of long-term (40-year) and short-term (5-year) shipments at the INEL were considered in determining the annual shipment rates for each alternative. The basis for the number of long-term shipments include spent nuclear fuel the INEL will continue to receive from operating reactors such as DOE, Naval Nuclear Propulsion Program, university, and research reactors. Short-term shipments consist of shipments that would be required to relocate existing spent fuel inventories between sites under the various alternatives. Table 5.15-6 summarizes the estimated annual shipment rate to and from the INEL under each alternative, and within INEL site boundaries. The estimates provided in Table 5.15-6 consider both onsite and offsite shipments.

Table 5.15-6. Determination of accident frequency adjustment factors for Alternatives 2 through 5 based on estimated number of annual spent nuclear fuel shipments under each alternative.[a]

Alternative		Estimated Shipment Rate (per year)[a]	Adjustment Factor (shipment rate/baseline)
1.	No Action	41	Baseline
2.	Decentralization	50	1.2
3.	1992/1993 Planning Basis	128	3.1
4a.	Regionalization by Fuel Type	195	4.8
4b(1)	Regionalization by Geography (INEL)	824	20.0
4b(2)	Regionalization by Geography (Elsewhere)	351	8.6
5a.	Centralization at Other DOE Sites	351	8.6
5b.	Centralization at the INEL	824	20.0

a. Data presented for the estimated annual shipment rate is based on information tabulated in Appendix I. The annual shipment rate for the No-Action Alternative (baseline) is derived from Table 3 of Wichmann 1994.

Based on the number of annual shipments estimated for Alternatives 2 through 5, as listed in Table 5.15-6, the analysis calculated multiplication factors by dividing the estimated shipment rates under Alternatives 2 through 5 by the baseline (Alternative 1) shipment rate. To determine the estimated frequency for the maximum reasonably foreseeable mechanical handling accidents under each alternative, the frequency identified for Alternative 1 was multiplied by the appropriate adjustment factor. The same approach determined estimated frequencies for Accident 1 (fuel pin breach and noble gases and iodine release from the Hot Fuel Examination Facility) under Alternatives 2 through 5. For Accident 2 (inadvertent criticality in the CPP-603 Underwater Fuel Storage Facility resulting from a handling accident associated with degraded spent nuclear fuel), the estimated frequency considered under Alternative 1 (1×10^{-3} event per year) is based on the number of handling activities associated with relocation of the CPP-603 spent nuclear fuel inventories to the CPP-666 facility. Because proposed changes in INEL inventories under the different alternatives would not affect handling events associated with relocating spent fuel from the CPP-603 facility to the CPP-666 facility, the estimated frequency for this mechanical handling event would not change. As a result of this approach and the fact that 3 of the 4 accident scenarios that present the greatest consequences are not handling accidents, Accident 1 is the only accident requiring "adjustment" for each alternative.

Variable source-term-sensitive accidents would have consequences that depended on the amount of spent nuclear fuel in storage. One example is the accidental drainage of a spent fuel storage canal that results in the release of corrosion products in the canal to the environment. The larger the spent fuel inventory in the canal, the larger the release of corrosion products to the environment resulting from draining the canal. (Drainage of a water canal completely filled with spent nuclear fuel was considered in the determination of the maximum reasonably foreseeable accidents and was determined to present lower consequences than other accident scenarios analyzed.) Variable source-term sensitive accidents depend only on spent nuclear fuel inventories and do not require adjustment of their estimated frequencies of occurrence. Because none of the postulated accidents summarized under Alternative 1 is source-term sensitive (e.g., spent nuclear fuel inventories in the Hot Fuel Examination Facility are not likely to increase), adjustment of the estimated consequences calculated under Alternative 1 is not required for Alternatives 2 through 5.

5.15.4 Impacts from Postulated Maximum Reasonably Foreseeable Radiological Accidents

Section 5.15.4.1 summarizes impacts (e.g., exposures and health effects) from the four nonprocessing-related maximum reasonably foreseeable radiological accidents postulated under

Alternative 1 (No Action). Sections 5.15.4.4.2.1 through 5.15.4.5.2 describe changes in these postulated accident impacts resulting from changes in spent nuclear fuel inventories and handling activities under the other alternatives. Sections 5.15.4.4.2.1 and 5.15.4.5.2 also summarize impacts from three additional maximum reasonably foreseeable accidents associated with resumption of processing activities at the INEL. Section 5.15.6 provides more information about the assumptions and analyses performed for each of the radiological accidents discussed under each alternative.

5.15.4.1 Alternative 1: No Action. Based on the quantity of spent nuclear fuel at the INEL (excluding naval fuel at Naval Reactors Facility, which is analyzed in Appendix D), its storage configuration (wet versus dry), the amount of time the spent fuel has been allowed to cool, and consideration of various internal, external, and natural phenomena initiators (as discussed in Section 5.15.3), the postulated accidents listed in Table 5.15-7 would have the greatest radiological consequences within the abnormal event, design-basis accident, and beyond-design-accident categories under this alternative. For each accident, Table 5.15-7 also lists estimated accident frequencies; radiation exposures to the offsite population within 80 kilometers (50 miles), a member of the public stranded at the nearest point of public access inside the INEL site boundary, a hypothetical maximally exposed individual (MEI) at the nearest site boundary, and a worker; point estimates of the annualized risk of the maximally exposed individual contracting a fatal cancer during his/her lifetime as a result of the radiation exposure; and point estimates of risk of the expected number of fatal cancers (annualized and total) in the offsite population. The estimates of the consequences and risk to the offsite population are based on conservative (95 percentile) and average (50 percentile) meteorological conditions[5]. The estimates of the consequences and risk to the maximally exposed individual are based on conservative (95 percentile) meteorological conditions. The postulated accidents listed in Table 5.15-7, in conjunction with the maximum reasonably foreseeable spent nuclear fuel accidents identified for the INEL Naval Reactors Facility in Appendix D, characterize the potential consequences and risks associated with the proposed spent fuel management activities at the INEL under this alternative.

Atmospheric transport of radionuclides from the postulated accidents could result in some secondary impacts, such as contamination of the environment or impacts to national defense. To

5 Conservative (95 percentile) meteorological conditions are defined as the meteorological conditions that, for a given release, the concentration at a fixed receptor location will not be exceeded 95 percent of the time. Average (50 percentile) meteorological conditions are defined as the meteorological conditions that, for a given release, the concentration at a fixed receptor location will not be exceeded 50 percent of the time.

Table 5.15-7. Impacts from selected maximum reasonably foreseeable radiological accidents - Alternative 1, No Action (50 and 95 percentile meteorological conditions).

Accident	Frequency (events per year)	Worker Dose[a] (rem)	Nearest Public Access[b] (rem)	Dose to MEI[c] (rem)	Offsite Population Dose (95%) (person-rem)	Point estimates of risk of fatal cancers (per year): MEI 95%[d]	Offsite Population 50%	Offsite Population 95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[e]	1.0×10^{-2}	(f)	(f)	2.0×10^{-3}	(f)	1.0×10^{-8}	(f)	(f)
2. Inadvertent criticality in ICPP[g] CPP-603 storage facility[h]	1.0×10^{-3}	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{1}	5.0×10^{-10}	6.5×10^{-9} (6.5×10^{-6})[d]	3.0×10^{-7} (3.0×10^{-4})[d]
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5}	6.2×10^{-1}	6.5×10^{-1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} (4.5×10^{-2})[d]	7.0×10^{-5} (7.0×10^{0})[d]
4. Material release from HFEF resulting from aircraft crash and ensuing fire	1.0×10^{-7}[(i)]	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} (3.6×10^{-1})[d]	1.0×10^{-7} (1.0×10^{0})[d]

a. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
b. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
c. MEI = Maximally exposed hypothetical offsite individual, located at the nearest site boundary.
d. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses 20 rem or more the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate the total number of fatal cancers in the population if the accident occurred.
e. HFEF - Hot Fuel Examination Facility.
f. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4.
g. ICPP = Idaho Chemical Processing Plant.
h. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred at the INEL during its 40-year operating history, the estimated frequency for an inadvertent criticality is not based on historic reprocessing data because reprocessing is not considered under this alternative. Nominal frequency estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) event per year.
i. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

prevent these radionuclides from increasing any potential safety concerns, DOE would initiate cleanup activities if an accident occurred, and no irreversible environmental impacts would be likely.

Table 5.15-8 summarizes postulated secondary impacts resulting from the postulated radiological accidents listed in Table 5.15-7.

This analysis takes limited credit for emergency response actions in determining the consequences listed in Table 5.15-7. DOE would initiate INEL emergency response programs, as appropriate, following the occurrence of an accident to prevent or mitigate potential consequences. These emergency response programs, implemented in accordance with 5500-DOE series Orders, typically involve emergency planning, emergency preparedness, and emergency response actions. Each emergency response plan utilizes resources specifically dedicated to assist a facility in emergency management. These resources include but are not limited to the following:

- INEL Warning Communications Center
- INEL Fire Department
- Facility Emergency Command Centers
- DOE Emergency Operations Centers
- County and State Emergency Command Centers
- Medical, health physics, and industrial hygiene specialists
- Protective clothing and equipment (respirators, breathing air supplies, etc.)
- Periodic training exercises and drills within and between the organizations involved in implementing the response plans

5.15.4.2 Alternative 2: Decentralization. Adjustments in estimated accident frequencies and point estimates of risk presented for Alternative 1 would be related to (1) the receipt, handling, and storage activities associated with the additional spent nuclear fuel inventories; and (2) the increase in overall spent nuclear fuel-related storage, relocation, and handling activities not allowed under Alternative 1. Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel inventories (i.e., the same amount of radioactive material would accidentally be released to the environment as discussed in Section 5.15.3.3), no changes are likely in the postulated secondary impacts listed in Table 5-15-8. Table 5.15-9 summarizes the four postulated accidents with the greatest radiological impacts under this alternative.

Table 5.15-8. Estimated secondary impacts resulting from the maximum reasonably foreseeable accidents postulated under Alternative 1, No Action, assuming conservative (95 percentile) meteorological conditions.

Radiological Accident Summary	Environmental or Social Impacts (Assuming 88 millirem per year limit with 24-hour-per-day exposure)[a]							
	Biotic Resources	Water Resources	Economic Impacts	National Defense	Environmental Contamination	Endangered Species	Land Use	Treaty Rights & Tribal Resources
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[b] (1×10^{-2} per year)	Limited adverse effects expected to vegetation or wildlife.	Limited adverse effects expected to surface water or groundwater.	Limited economic impacts expected. Any cleanup required would be localized and could be accomplished with existing workforce and equipment.	No effects on national defense expected.	Local contamination requiring cleanup expected around site accident.	No impacts exptected to endangered or threatened species.	No change in land use or irreversible impacts expected.	No irreversible impacts to Native Americans or public lands expected.
2. Uncontrolled chain reaction (criticality) at ICPP[c] (1×10^{-3} per year)	Limited adverse effects expected to vegetation or wildlife.	Limited adverse effects expected to surface water or groundwater.	No economic impacts expected. Any cleanup required would be localized and could be accomplished with existing workforce and equipment.	No effects on national defense expected.	Local contamination requiring cleanup expected around site accident.	No impacts exptected to endangered or threatened species.	No change in land use or irreversible impacts expected.	No irreversible impacts to Native American or public lands expected.
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach (1×10^{-5} per year)	Limited adverse effects expected to vegetation or wildlife.	Limited adverse effects expected to surface water or groundwater.	Potential interdiction of affected agricultural products on nearby lands. Local cleanup in the vicinity of HFEF.	No effects on national defense expected.	Local contamination requiring cleanup expected around site accident.	No impacts exptected to endangered or threatened species.	Potential for 1 year of agricultural land withdrawal of up to 10,000 acres[d] (on and off the INEL site).	Potential for temporary restricted access to affected public land (less than 10,000 acres).[d]
4. Material release from HFEF resulting from aircraft crash and ensuing fire (1×10^{-7} per year)	Limited adverse effects expected to vegetation or wildlife.	Limited adverse effects expected to surface water or groundwater.	Potential interdiction of affected agricultural products on nearby lands. Local cleanup in the vicinity of HFEF.	No effects on national defense expected.	Local contamination requiring cleanup expected around site accident.	No impacts exptected to endangered or threatened species.	Potential for 1 year of agricultural withdrawal of up to 10,000 acres[d] (on and off the INEL site).	Potential for temporary restricted access to affected public land (less than 10,000 acres).[d]

a. Postulated secondary impacts based on 10-microrem-per-hour exposure (88 millirem per year with 24-hour-per-day exposure) from ground contamination resulting from radionuclide deposition from the plume. This approach in estimated secondary impacts is conservative because DOE Order 5400.5 states that the public dose limit for exposure to residual contamination and natural background radiation is 100 millirem per year.

b. HFEF = Hot Fuel Examination Facility.

c. ICPP = Idaho Chemical Processing Plant.

d. To convert acres to square kilometers, multiply by 0.004.

Table 5.15-9. Impacts from selected maximum reasonably foreseeable accidents - Alternative 2, Decentralization (50 and 95 percentile meteorological conditions).

Accident	Adjusted Frequency[a] (events per year)	Worker Dose[b] (rem)	Nearest Public Access[c] (rem)	Dose to MEI[d] (rem)	Offsite Population Dose (95%) (person-rem)	Adjusted point estimates of risk of fatal cancers (per year) MEI 95%[e]	Offsite 50%	Population 95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[f]	1.2×10^{-2} (1.2)	(g)	(g)	2.0×10^{-3}	(g)	1.2×10^{-8}	(g)	(g)
2. Inadvertent criticality in ICPP[h] CPP-603 storage facility[i]	1.0×10^{-3} (1.0)[j]	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{-1}	5.0×10^{-10}	6.5×10^{-9} (6.5×10^{-6})[e]	3.0×10^{-7} (3.0×10^{-4})[e]
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5} (1.0)	6.2×10^{-1}	6.5×10^{-1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} (4.5×10^{-2})[e]	7.0×10^{-5} (7.0×10^{0})[e]
4. Material release from HFEF resulting from aircraft crash and ensuing fire	1.0×10^{-7}[(k)] (1.0)	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} (3.6×10^{-1})[e]	1.0×10^{-7} (1.0×10^{0})[e]

a. Numbers in parentheses indicate multiplication factor used to scale or adjust estimated accident frequencies under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
c. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest site boundary.
e. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or more, the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate total number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred at the INEL during its 40-year operating history, the estimated frequency for an inadvertent criticality is not based on historic reprocessing data since reprocessing is not considered under this alternative. Nominal frequency estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was not adjusted under this alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

5.15.4.3 Alternative 3: 1992/1993 Planning Basis. Under this alternative, the INEL could receive the following spent nuclear fuel:

- Spent nuclear fuel from domestic DOE and university reactors and foreign research test reactors
- All Training Reactor Isotopics General Atomics (TRIGA) spent nuclear fuel from foreign and Hanford reactors
- Fort St. Vrain spent nuclear fuel from Public Service Company of Colorado
- Special case commercial pressurized water reactor and boiling water reactor spent nuclear fuel from West Valley, New York
- Naval spent nuclear fuel from sites such as the Norfolk or Puget Sound Naval Shipyard.

Adjustments in estimated accident frequencies and point estimates of risk presented for Alternative 1 would be related to (1) the receipt, handling, and storage activities associated with the additional spent nuclear fuel inventories; and (2) the increase in overall spent fuel-related storage, relocation, and handling activities not allowed under Alternative 1. Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel inventories (i.e., the same amount of radioactive material would accidentally be released to the environment as discussed in Section 5.15.3.3), no changes are likely in the postulated secondary impacts listed in Table 5.15-8. Table 5.15-10 summarizes the postulated accidents with the greatest radiological impacts under this alternative.

5.15.4.4 Alternative 4: Regionalization. Under this alternative, there are two primary Regionalization alternatives: (1) Alternative 4a (Regionalization by Fuel Type), where existing and spent nuclear fuel inventories will be distributed between the DOE sites based primarily on the similarity of fuel types, although DOE would also consider transportation distances, available stabilization capabilities, available storage capacities, or a combination of these factors; or (2) Alternative 4b (Regionalization by Geography), where existing and new spent nuclear fuel inventories in the western region of the country will be centralized at a single western site, and existing and new spent nuclear fuel inventories in the eastern region of the country will be centralized at a single eastern site.

Table 5.15-10. Impacts from selected maximum reasonably foreseeable accidents - Alternative 3, Planning Basis (50 and 95 percentile meteorological conditions).

Accident	Adjusted Frequency[a] (events per year)	Worker Dose[b] (rem)	Nearest Public Access[c] (rem)	Dose to MEI[d] (rem)	Offsite Population Dose (95%) (person-rem)	Adjusted point estimates of risk of fatal cancers (per year)		
						MEI	Offsite Population	
						95%[e]	50%	95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[f]	3.1×10^{-2} (3.1)	(g)	(g)	2.0×10^{-3}	(g)	3.1×10^{-8}	(g)	(g)
2. Inadvertent criticality in ICPP[h] CPP-603 storage facility[i]	1.0×10^{-3} (1.0)[j]	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{-1}	5.0×10^{-10}	6.5×10^{-9} (6.5×10^{-6})[e]	3.0×10^{-7} (3.0×10^{-4})[e]
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5} (1.0)	6.2×10^{-1}	6.5×10^{-1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} (4.5×10^{-2})[e]	7.0×10^{-5} (7.0×10^{0})[e]
4. Material release from HFEF resulting from aircraft crash and ensuing fire	1.0×10^{-7}[k] (1.0)	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} (3.6×10^{-1})[e]	1.0×10^{-7} (1.0×10^{0})[e]

a. Numbers in parentheses indicate multiplication factor used to scale or adjust estimated accident frequencies under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
c. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest site boundary.
e. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or more, the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate total number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4. However, given the high frequency for this accident compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred at the INEL during its 40-year operating history, the estimated frequency for an inadvertent criticality is not based on historic reprocessing data since reprocessing is not considered under this alternative. Nominal frequency estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was not adjusted under this alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

5.15.4.4.1 Alternative 4a - Regionalization By Fuel Type — Adjustments in the estimated accident frequencies and point estimates of risk presented for Alternative 1 would be related to (1) the receipt, handling, and storage activities associated with the additional spent nuclear fuel inventories; and (2) the increase in overall spent nuclear fuel-related storage, relocation, and handling activities not allowed under Alternative 1. Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel inventories (i.e., the same amount of radioactive material would accidentally be released to the environment as discussed in Section 5.15.3.3), no changes are likely in the postulated secondary impacts listed in Table 5.15-8. Table 5.15-11 summarizes the postulated accidents with the greatest radiological impacts under this alternative.

5.15.4.4.2 Alternative 4b - Regionalization by Geography — Under this alternative, spent nuclear fuel inventories in the western region of the country would be centralized at either the INEL, Hanford Site, or Nevada Test Site. Alternative 4b(1) considers regionalization at the INEL. Alternative 4b(2) considers regionalization at the Hanford Site or Nevada Test Site.

5.15.4.4.2.1 Alternative 4b(1) - Regionalization by Geography (INEL) — Under this alternative, existing and new spent nuclear fuel inventories in the western region of the country would be centralized at the INEL. Fuel stabilization would be performed in the Fluorinel and Storage (FAST) facility (CPP-666) and a new facility to be constructed, the Fuel Processing Restoration facility (CPP-691), to dissolve spent nuclear fuel and stabilize (i.e., immobilize) radionuclides. Because the volume of spent nuclear fuel considered under this alternative is only slightly lower than that considered under Alternative 5b, adjustments in the estimated accident frequencies and point estimates of risk for the four accidents presented under Alternative 1 were conservatively considered equivalent to the adjustments required under Alternative 5b (i.e., centralization of all the DOE, Naval Nuclear Propulsion Program, university, and research reactor spent nuclear fuel in the country at the INEL). Adjustments in the estimated accident frequencies and point estimates of risk for the four accidents presented under Alternative 1 would be related to (1) the receipt, handling, and storage activities associated with the additional spent nuclear fuel inventories; and (2) the increase in overall spent nuclear fuel-related storage, relocation, and handling activities not allowed under Alternative 1. Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel inventories (i.e., the same amount of radioactive material would accidentally be released to the environment as discussed in Section 5.15.3.3), no changes are likely in the postulated secondary impacts listed in Table 5.15-8.

Table 5.15-11. Impacts from selected maximum reasonably foreseeable accidents - Alternative 4a, Regionalization by Fuel Type (50 and 95 percentile meteorological conditions).

Accident	Adjusted Frequency[a] (events per year)	Worker Dose[b] (rem)	Nearest Public Access[c] (rem)	Dose to MEI[d] (rem)	Offsite Population Dose (95%) (person-rem)	Adjusted point estimates of risk of fatal cancers (per year): MEI 95%[e]	Offsite Population 50%	Offsite Population 95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[f]	4.8×10^{-2} (4.8)	(g)	(g)	2.0×10^{-3}	(g)	4.8×10^{-8}	(g)	(g)
2. Inadvertent criticality in ICPP[h] CPP-603 storage facility[i]	1.0×10^{-3} $(1.0)^j$	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{-1}	5.0×10^{-10}	6.5×10^{-9} $(6.5\times10^{-6})^e$	3.0×10^{-7} $(3.0\times10^{-4})^e$
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5} (1.0)	6.2×10^{-1}	6.5×10^{-1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} $(4.5\times10^{-2})^e$	7.0×10^{-5} $(7.0\times10^{0})^e$
4. Material release from HFEF resulting from aircraft crash and ensuing fire	$1.0\times10^{-7(k)}$ (1.0)	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} $(3.6\times10^{-1})^e$	1.0×10^{-7} $(1.0\times10^{0})^e$

a. Numbers in parentheses indicate multiplication factor used to scale or adjust estimated accident frequencies under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
c. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest site boundary.
e. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or more, the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate total number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4. However, given the high frequency for this accident compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred at the INEL during its 40-year operating history, the estimated frequency for an inadvertent criticality is not based on historic reprocessing data since reprocessing is not considered under this alternative. Nominal frequency estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was not adjusted under this alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

Because the option exists to restart processing activities, three additional processing-related maximum reasonably foreseeable accidents are considered under this alternative (as discussed in Section 5.15.3.2). Since the amount of radioactive material that would accidentally be released to the environment from these accidents is expected to be lower than in Accidents 3 and 4 (i.e., small fuel melt and aircraft crash at the Hot Fuel Examination Facility, respectively), potential secondary impacts associated with these additional processing-related accidents would be less severe than those presented for the nonprocessing-related accidents in Table 5.15-8.

Table 5.15-12 summarizes the postulated accidents with the greatest radiological impacts under this alternative.

5.15.4.4.2.2 Alternative 4b(2) - Regionalization by Geography (Elsewhere) — Under this alternative, existing and new spent nuclear fuel inventories in the western region of the country would be centralized at either the Hanford Site or Nevada Test Site. Similar to Alternative 5a, which considers centralization of existing INEL spent nuclear fuel inventories at another DOE site, the inventory of spent nuclear fuel at the INEL would be reduced substantially so that the only spent nuclear fuel at the INEL would consist of fresh fuel generated from operating INEL reactors that had not cooled sufficiently for relocation to the regionalized or centralized site. Therefore, this alternative considers the same amount of material considered under Alternative 1 until the regionalized site could accept existing inventories of INEL spent nuclear fuel and freshly generated spent nuclear fuel that has sufficiently cooled.

Table 5.15-13 summarizes the postulated accidents with the greatest radiological impacts under this alternative.

5.15.4.5 Alternative 5: Centralization. Under this alternative, DOE would collect all current and future spent nuclear fuel inventories from both DOE and the Naval Nuclear Propulsion Program at one site. For the INEL, there are two possibilities: (1) Alternative 5a, in which most spent fuel inventories and activities would take place at the Hanford Site, Savannah River Site, Nevada Test Site, or Oak Ridge Reservation; or (2) Alternative 5b, in which all spent fuel inventories and activities would be centralized at the INEL.

5.15.4.5.1 Alternative 5a: Centralization at Other DOE Sites — This alternative would consider approximately the same amount of material considered under Alternative 1 until the centralized site could accept existing INEL spent nuclear fuel inventories and freshly generated spent

Table 5.15-12. Impacts from selected maximum reasonably foreseeable accidents - Alternative 4b(1), Regionalization by Geography (INEL) (50 and 95 percentile meteorological conditions).

Accident	Adjusted Frequency[a] (events per year)	Worker Dose[b] (rem)	Nearest Public Access[c] (rem)	Dose to MEI[d] (rem)	Offsite Population Dose (95%) (person-rem)	Adjusted point estimates of risk of fatal cancers (per year)		
						MEI	Offsite Population	
						95%[e]	50%	95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[f]	2.0×10^{-1} (20.0)	(g)	(g)	2.0×10^{-3}	(g)	2.0×10^{-7}	(g)	(g)
2. Inadvertent criticality in ICPP[h] CPP-603 storage facility[i]	1.0×10^{-3} (1.0)[j]	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{-1}	5.0×10^{-10}	6.5×10^{-9} $(6.5\times10^{-6})^{e}$	3.0×10^{-7} $(3.0\times10^{-4})^{e}$
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5} (1.0)	6.2×10^{-1}	6.5×10^{-1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} $(4.5\times10^{-2})^{e}$	7.0×10^{-5} $(7.0\times10^{0})^{e}$
4. Material release from HFEF resulting from aircraft crash and ensuing fire	1.0×10^{-7}[k] (1.0)	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} $(3.6\times10^{-1})^{e}$	1.0×10^{-7} $(1.0\times10^{0})^{e}$
5. Inadvertent nuclear criticality ICPP[h] CPP-666 during processing[l]	1.0×10^{-3}	$9.1\times10^{+0}$	4.9×10^{-2}	2.8×10^{-2}	$5.6\times10^{+0}$	1.4×10^{-8}	3.1×10^{-6} (3.1×10^{-3})	2.8×10^{-6} (2.8×10^{-3})
6. Hydrogen in ICPP[h] CPP-666 dissolver	1.0×10^{-5}	(m)	(m)	6.3×10^{-4}	8.1×10^{-1}	3.2×10^{-12}	(m)	4.1×10^{-9} (4.1×10^{-4})
7. Inadvertent dissolution of 30-day cooled fuel at ICPP[h] CPP-666	1.0×10^{-6}	(m)	(m)	3.0×10^{-2}	$2.9\times10^{+1}$	1.5×10^{-11}	(m)	1.5×10^{-8} (1.5×10^{-8})

a. Numbers in parentheses indicate multiplication factor used to scale or adjust estimated accident frequencies under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
c. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest site boundary.
e. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or more, the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate total number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from Accident 1 could be less than the consequences from Accidents 2 through 4. However, given the high frequency for Accident 1 compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred during the 40-year operating history of CPP-666, the estimated frequency for an inadvertent criticality in this facility is based on existing spent nuclear conditions and fuel vulnerabilities. Nominal estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was not adjusted under this alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.
l. The Idaho Chemical Processing Plant has experienced three inadvertent nuclear criticalities during its operating history, the last one 14 years ago. This frequency is based on modern facility conditions and safeguards that exist at CPP-666.
m. The safety analysis report utilized for this accident does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. However, a comparison of the data presented for this accident to the other accidents provides a relative measure of the impacts to this receptor.

Table 5.15-13. Impacts from selected maximum reasonably foreseeable accidents - Alternative 4b(2), Regionalization by Geography (Elsewhere) (50 and 95 percentile meteorological conditions).

Accident	Adjusted Frequency[a] (events per year)	Worker Dose[b] (rem)	Nearest Public Access[c] (rem)	Dose to MEI[d] (rem)	Offsite Population Dose (95%) (person-rem)	Adjusted point estimates of risk of fatal cancers (per year): MEI 95%[e]	Offsite Population 50%	Offsite Population 95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[f]	8.6×10^{-2} (8.6)	(g)	(g)	2.0×10^{-3}	(g)	8.6×10^{-8}	(g)	(g)
2. Inadvertent criticality in ICPP[h] CPP-603 storage facility[i]	1.0×10^{-3} (1.0)[j]	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{-1}	5.0×10^{-10}	6.5×10^{-9} (6.5×10^{-6})[e]	3.0×10^{-7} (3.0×10^{-4})[e]
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5} (1.0)	6.2×10^{1}	6.5×10^{1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} (4.5×10^{-2})[e]	7.0×10^{-5} (7.0×10^{0})[e]
4. Material release from HFEF resulting from aircraft crash and ensuing fire	1.0×10^{-7}[(k)] (1.0)	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} (3.6×10^{-1})[e]	1.0×10^{-7} (1.0×10^{0})[e]

a. Numbers in parentheses indicate multiplication factor used to scale or adjust estimated accident frequencies under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
c. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest site boundary.
e. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or more, the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate total number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4. However, given the high frequency for this accident compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred at the INEL during its 40-year operating history, the estimated frequency for an inadvertent criticality is not based on historic reprocessing data since reprocessing is not considered under this alternative. Nominal frequency estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was not adjusted under this alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

fuel that had cooled sufficiently. On demonstration of the centralized site's capability to receive INEL spent nuclear fuel, the inventory of spent fuel at the INEL would be reduced substantially so that the only spent nuclear fuel at the INEL would consist of fresh fuel generated from operating INEL reactors that had not cooled sufficiently for relocation to the centralized site.

Adjustments in estimated accident frequencies and point estimates of risk presented for Alternative 1 would be related to (1) the receipt, handling, and storage activities associated with the additional spent nuclear fuel inventories; and (2) the increase in overall spent fuel-related storage, relocation, and handling activities not allowed under Alternative 1. Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel inventories (i.e., the same amount of radioactive material would accidentally be released to the environment as discussed in Section 5.15.3.3), no changes are likely in the postulated secondary impacts presented in Table 5.15-8. Table 5.15-14 summarizes the postulated accidents with the greatest radiological impacts under these alternatives.

5.15.4.5.2 Alternative 5b: Centralization at the INEL — Adjustments in estimated accident frequencies and point estimates of risk presented for Alternative 1 would be related to (1) the receipt, handling, and storage activities associated with the additional spent nuclear fuel inventories; and (2) the increase in overall spent nuclear fuel-related storage, relocation, and handling activities not allowed under Alternative 1. Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel inventories (i.e., the same amount of radioactive material would accidentally be released to the environment as discussed in Section 5.15.3.3), no changes are likely in the postulated secondary impacts presented in Table 5.15-8. Table 5.15-15 summarizes the postulated accidents with the greatest radiological impacts under this alternative.

Because the option exists to restart processing activities, three additional processing-related maximum reasonably foreseeable accidents are considered under this alternative (as discussed in Section 5.15.3.2). Since the amount of radioactive material that would accidentally be released to the environment from these accidents is expected to be lower than Accidents 3 and 4 (i.e., small fuel melt and aircraft crash at the Hot Fuel Examination Facility, respectively), potential secondary impacts associated with these additional processing-related accidents would be less severe than those presented for the nonprocessing-related accidents in Table 5.15-8.

Table 5.15-14. Impacts from selected maximum reasonably foreseeable accidents - Alternative 5a, Centralization at Other DOE Sites (50 and 95 percentile meteorological conditions).

Accident	Adjusted Frequency[a] (events per year)	Worker Dose[b] (rem)	Nearest Public Access[c] (rem)	Dose to MEI[d] (rem)	Offsite Population Dose (95%) (person-rem)	Adjusted point estimates of risk of fatal cancers (per year): MEI 95%[e]	Offsite Population 50%	Offsite Population 95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[f]	8.6×10^{-2} (8.6)	(g)	(g)	2.0×10^{-3}	(g)	8.6×10^{-8}	(g)	(g)
2. Inadvertent criticality in ICPP[h] CPP-603 storage facility[i]	1.0×10^{-3} (1.0)[j]	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{-1}	5.0×10^{-10}	6.5×10^{-9} $(6.5\times10^{-6})^{e}$	3.0×10^{-7} $(3.0\times10^{-4})^{e}$
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5} (1.0)	6.2×10^{-1}	6.5×10^{-1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} $(4.5\times10^{-2})^{e}$	7.0×10^{-5} $(7.0\times10^{0})^{e}$
4. Material release from HFEF resulting from aircraft crash and ensuing fire	$1.0\times10^{-7(k)}$ (1.0)	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} $(3.6\times10^{-1})^{e}$	1.0×10^{-7} $(1.0\times10^{0})^{e}$

a. Numbers in parentheses indicate multiplication factor used to scale or adjust estimated accident frequencies under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
c. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest site boundary.
e. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or more, the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate total number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4. However, given the high frequency for this accident compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred at the INEL during its 40-year operating history, the estimated frequency for an inadvertent criticality is not based on historic reprocessing data since reprocessing is not considered under this alternative. Nominal frequency estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was not adjusted under this alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.

Table 5.15-15. Impacts from selected maximum reasonably foreseeable accidents - Alternative 5b, Centralization at the INEL (50 and 95 percentile meteorological conditions).

Accident	Adjusted Frequency[a] (events per year)	Worker Dose[b] (rem)	Nearest Public Access[c] (rem)	Dose to MEI[d] (rem)	Offsite Population Dose (95%) (person-rem)	Adjusted point estimates of risk of fatal cancers (per year): MEI 95%[e]	Offsite Population 50%	Offsite Population 95%
1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEF[f]	2.0×10^{-1} (20.0)	(g)	(g)	2.0×10^{-3}	(g)	2.0×10^{-7}	(g)	(g)
2. Inadvertent criticality in ICPP[h] storage facility[i]	1.0×10^{-3} (1.0)[j]	9.7×10^{-2}	1.4×10^{-3}	1.0×10^{-3}	5.9×10^{-1}	5.0×10^{-10}	6.5×10^{-9} $(6.5\times10^{-6})^{e}$	3.0×10^{-7} $(3.0\times10^{-4})^{e}$
3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach	1.0×10^{-5} (1.0)	6.2×10^{-1}	6.5×10^{-1}	5.0×10^{0}	1.4×10^{4}	2.5×10^{-8}	4.5×10^{-7} $(4.5\times10^{-2})^{e}$	7.0×10^{-5} $(7.0\times10^{0})^{e}$
4. Material release from HFEF resulting from aircraft crash and ensuing fire	$1.0\times10^{-7(k)}$ (1.0)	4.6×10^{0}	3.2×10^{-1}	5.0×10^{0}	2.0×10^{3}	2.5×10^{-10}	3.6×10^{-8} $(3.6\times10^{-1})^{e}$	1.0×10^{-7} $(1.0\times10^{0})^{e}$
5. Inadvertent nuclear criticality ICPP[h] CPP-666 during processing[l]	1.0×10^{-3}	$9.1\times10^{+0}$	4.9×10^{-2}	2.8×10^{-2}	$5.6\times10^{+0}$	1.4×10^{-8}	3.1×10^{-6} (3.1×10^{-3})	2.8×10^{-6} (2.8×10^{-3})
6. Hydrogen in ICPP[h] CPP-666 dissolver	1.0×10^{-5}	(m)	(m)	6.3×10^{-4}	8.1×10^{-1}	3.2×10^{-12}	(m)	4.1×10^{-9} (4.1×10^{-4})
7. Inadvertent dissolution of 30-day cooled fuel at ICPP[h] CPP-666	1.0×10^{-6}	(m)	(m)	3.0×10^{-2}	$2.9\times10^{+1}$	1.5×10^{-11}	(m)	1.5×10^{-8} (1.5×10^{-2})

a. Numbers in parentheses indicate multiplication factor used to scale or adjust estimated accident frequencies under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of release.
c. Public individual assumed to be stranded at the nearest point of public access inside the site boundary.
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest site boundary.
e. Maximally exposed individual and offsite population fatal cancer risk = dose × accident frequency × 5.0×10^{-4} fatal cancer per rem (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or more, the ICRP-60 conversion factor is doubled, or 1.0×10^{-3}. Numbers in parentheses indicate total number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide this information because it was developed prior to DOE Orders requiring this information. As demonstrated by the dose to the maximally exposed individual, consequences to the public from this accident could be less than the consequences from Accidents 2 through 4. However, given the high frequency for this accident compared to Accidents 2 through 4, the risk could actually be greater than for Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reprocessing activities have occurred during the 40-year operating history of CPP-666, the estimated frequency for an inadvertent criticality in this facility is based on existing spent nuclear conditions and fuel vulnerabilities. Nominal estimates vary from 1.0×10^{-4} (CPP-666 underwater storage facility) to 1.0×10^{-3} (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was not adjusted under this alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash, as discussed in Section 5.15.6.4.
l. The Idaho Chemical Processing Plant has experienced three inadvertent nuclear criticalities during its operating history, the last one 14 years ago. This frequency is based on modern facility conditions and safeguards that exist at CPP-666.
m. The safety analysis report utilized for this accident does not provide this information because it was developed prior to DOE Order 5480.23 requiring this information. However, a comparison of the data presented for this accident to the other accidents provides a relative measure of the impacts to this receptor.

5.15.5 Impacts from Postulated Maximum Reasonably Foreseeable Toxic Material Accidents

Like radioactive materials, toxic materials (e.g., chemicals) are involved in a variety of operations, including spent nuclear fuel-related activities, at the INEL. As a result of these operations and activities, the potential exists for releases of toxic materials to the environment from the same types of initiators considered in determining the radiological accident scenarios discussed in Section 5.15.4. This section summarizes analyses of postulated accident scenarios associated with spent nuclear fuel activities that could result in the release of toxic materials from their confinements.

5.15.5.1 Identification of Toxic Chemicals at the INEL. The facilities at the INEL use many types and quantities of chemically toxic materials. To determine the spent fuel-related chemicals that exist in sufficient quantities to present health effects to workers or the offsite population, DOE performed an initial screening of the chemical inventories at the INEL. This screening consisted of identifying those hazardous chemicals at the INEL listed in the Superfund Amendments and Reauthorization Act of 1986 (SARA) 312 Report for 1992 (Priestly 1992) that (1) exist in bulk quantities [assumed to be greater than 227 kilograms (500 pounds)]; or (2) exceed reportable quantities [usually 0.45 kilogram (1 pound)] on the EPA Title III List of Lists (EPA 1990), which includes hazardous chemicals defined in the following:

- SARA Section 302, Extremely Hazardous Substances (40 CFR Part 355, Appendixes A and B, List of Extremely Hazardous Substances and Their Threshold Planning Quantities) (CFR 1993)
- Comprehensive Environmental Response, Compensation, and Liability Act Hazardous Substances (40 CFR Part 302, Table 302.4, Lists of Hazardous Substances and Reportable Quantities) (CFR 1992a)
- SARA Section 313, Toxic Chemicals (CFR 1992b)
- Federal Register list of 100 extremely hazardous chemicals (FR 1994)

5.15.5.2 Selection of Spent Nuclear Fuel-Related Toxic Chemicals Requiring Accident Analysis. As indicated by the screening methodology discussed above, toxic chemical inventories are located throughout INEL facilities in varying quantities and are involved in nearly all operations and activities performed by INEL facilities, including spent nuclear fuel-related activities.

The screening identified no toxic chemicals associated with the dry storage of spent nuclear fuel. Except for processing-related activities that could be performed under the Regionalization and Centralization at INEL alternatives [i.e., Alternatives 4b(1) and 5b, respectively], the screening identified activities associated with the underwater storage of spent nuclear fuel (e.g., maintaining water chemistry) as the only spent nuclear-fuel related activities that might utilize toxic chemicals in sufficient quantities to present a potential for health effects to workers or the offsite population, or potential contamination of the environment. For Alternatives 4b(2) and 5a, in which DOE would relocate INEL spent nuclear fuel inventories and related activities to other DOE sites, the existing toxic chemical inventories at the INEL would be expected to slightly decrease. For Alternatives 4b(1) and 5b, in which the INEL could potentially resume processing activities, a substantial increase in existing chemical inventories, primarily hydrofluoric acid and anhydrous ammonia, would be expected. No substantial changes in existing spent nuclear fuel-related toxic chemical inventories would be expected under Alternatives 1, 2, or 3.

To demonstrate how the consequences of the same accident at an identical hypothetical facility constructed at the Hanford Site or the Savannah River Site under this alternative would compare to the INEL (based on local geological and meteorological conditions), Appendix D summarizes postulated accident scenarios for a new Expended Core Facility that DOE could construct at any of the sites considered in this EIS.

To determine potential accident scenarios associated with handling or storing toxic chemicals at the various spent nuclear fuel-related facilities, DOE performed an extensive review of existing safety analyses and walkdowns of various facilities. This review identified two nonprocessing-related toxic chemicals at the Idaho Chemical Processing Plant — nitric acid and chlorine — as requiring further evaluation to determine potential health effects to workers and the offsite population. Additionally, two toxic chemicals that would be required to support the resumption of processing activities at the Idaho Chemical Processing Plant — hydrofluoric acid and anhydrous ammonia — were identified as requiring further evaluation.[6] Although spent fuel-related facilities at the Idaho Chemical Processing Plant use several other toxic chemicals (e.g., oxalic acid), the quantities of these chemicals are not sufficient to present an impact to workers or the environment from accidental releases to the

6 Although bulk quantities of nitric acid would be required to perform processing activities that could be resumed under Alternatives 4b(1) and 5b, the consequences of processing-related accidents involving nitric acid would be bounded by the hydrofluoric acid and anhydrous accidents analyzed in Sections 5.15.5.3.3 and 5.15.5.3.4, respectively. Therefore, this analysis focuses on a potential nitric acid accident resulting from the nonprocessing spent nuclear fuel-related activities considered under the other alternatives.

environment. (For postulated accident scenarios involving Naval spent nuclear fuel-related activities at the INEL, refer to Appendix D.)

Because DOE determined that it needed to evaluate postulated toxic chemical accidents at the Idaho Chemical Processing Plant as part of this EIS, it did not consider postulated toxic chemical accidents at the Advanced Test Reactor Storage Canal and the Hot Fuel Examination Facility that could be involved in spent fuel-related activities[7] for further evaluation in this EIS for the following reasons:

- In general, quantities of spent nuclear fuel-related chemicals at the Idaho Chemical Processing Plant are substantially greater than those at the Advanced Test Reactor Storage Canal and Hot Fuel Examination Facility.

- The Idaho Chemical Processing Plant is located approximately 1,000 meters (1,094 yards) closer to the nearest site boundary than the Advanced Test Reactor.

Based on a review of safety documentation for the Test Area North spent nuclear fuel underwater storage facility and discussions with facility personnel, DOE determined that none of the toxic chemicals identified in the screening (Section 5.15.5.1) is related to spent fuel handling or storage activities.

5.15.5.3 Toxic Chemical Accident Analysis. For chemically toxic materials, several government agencies recommend quantifying health effects that cause short-term effects as threshold values of concentrations in air or water. The long-term health consequences of human exposure to toxic materials are not as well understood as the long-term health consequences related to radiation exposure. Thus, the potential health effects for exposures to toxic chemicals are more subjective than those for radioactive materials. Factors such as receptor locations, terrain, meteorological conditions, release conditions, and characteristics of chemical inventories are required parameters for determinations of airborne concentrations of toxic chemicals at various distances from a postulated point of release.

7 The scope of this analysis has been restricted to the Advanced Test Reactor fuel storage canal. Everything inside the reactor gas-tight boundary and associated with reactor operations has been excluded from consideration because reactor operations are not related to the spent nuclear fuel activities considered in this EIS.

EPICode™ was used to estimate airborne concentrations resulting from spent nuclear fuel-related toxic chemical releases at the INEL. [For a detailed description of EPICode™, refer to Slaughterbeck et al. (1995).]

To determine the potential health effects from accidental releases of toxic chemicals, this analysis compared the concentrations determined by EPICode™ against Emergency Response Planning Guideline values, where available. These values, which are specific for each substance, are related to three general severity levels:

- Exposure to concentrations greater than Emergency Response Planning Guideline-1 values for a period of time greater than 1 hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects, or perception of a clearly defined objectionable odor.

- Exposure to concentrations greater than Emergency Response Planning Guideline-2 values for a period of time greater than 1 hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects, or symptoms that could impair one's ability to take protective action.

- Exposure to concentrations greater than Emergency Response Planning Guideline-3 values for a period of time greater than 1 hour results in an unacceptable likelihood that a person would experience or develop life-threatening health effects.

If there were no Emergency Response Planning Guideline values for a toxic substance, the analysis substituted other chemical toxicity values, as follows:

- Threshold limit values/time-weighted average values (ACGIH 1988) substituted for Emergency Response Planning Guideline-1. This is the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers could be repeatedly exposed, day after day, without adverse effect.

- Level of concern values (equal to 0.1 of the immediately dangerous to life or health values - see below) substituted for Emergency Response Planning Guideline-2. The level of concern value is the concentration of a hazardous substance in the air above which there might be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

- Immediately dangerous to life or health values are substituted for Emergency Response Planning Guideline-3. The immediately dangerous to life or health value is the maximum concentration from which a person could escape within 30 minutes without a respirator and without experiencing any impairment of escape or irreversible side effects (NIOSH 1990).

As stated in the above section, four toxic chemicals — chlorine, nitric acid, hydrofluoric acid, and anhydrous ammonia — at the Idaho Chemical Processing Plant were identified as requiring further evaluation to estimate potential health effects to workers and the public. The following sections summarize the analyses performed for these chemicals.

5.15.5.3.1 Accidental Chlorine Release — Chlorine, while not directly associated with spent nuclear fuel-related activities at the INEL, is used to treat drinking water supplies at the various spent fuel facilities. Therefore, an analysis of a postulated accidental chlorine release at the Idaho Chemical Processing Plant was performed to determine potential impacts on workers operating the spent fuel-related facilities.

At the Idaho Chemical Processing Plant, chlorine is contained in two pressurized bottles [65 atmospheres at 20°C (68°F)], a 68-kilogram (150-pound) bottle and a 55-kilogram (120-pound) bottle, totaling 123 kilograms (270 pounds). To be conservative, DOE assumed that a breach of the drain line causes an instantaneous release of the total inventory of both tanks. The highest chlorine concentrations at the receptor locations would result from the largest release over the shortest time period. Therefore, the release duration was assumed to be approximately 5 minutes.

An accidental chlorine release from one of the chlorine tanks could be initiated by one of several events, such as a handling event, piping or valve rupture, or human error. Because the two tanks are physically separated, an accidental simultaneous release from both tanks would require a common initiator such as a delivery accident, a common maintenance failure, or a natural phenomena event (e.g., seismic) that damaged or punctured both tanks. The frequency of an accidental release from one pressurized tank is 1.0×10^{-4} event per year (EPA/FEMA/DOT 1987). A common cause failure resulting in the release of chlorine from two separated tanks is assumed to be no greater than 5 percent of the time given for the first tank failure. Therefore, the estimated frequency of an accidental release

from both tanks is 5.0×10^{-6} events per year (with no credit taken for pressure vessel management and training).

Table 5.15-16 summarizes the concentrations of the subject chlorine release at the following receptor locations: a facility worker, a member of the public stranded at the nearest point of public access inside the INEL boundary, and a maximally exposed hypothetical member of the public located at the nearest site boundary. As listed in Table 5.15-10, the peak chlorine concentrations for facility workers could result in life-threatening health effects (i.e., Emergency Response Planning Guideline-3 values are exceeded) for both conservative (95 percentile) and average (50 percentile) meteorological conditions.

Table 5.15-16. Summary of chemical concentrations for postulated nonprocessing-related accidental releases at the Idaho Chemical Processing Plant under Alternatives 1 through 5.

	Chemical Concentrations (milligrams per cubic meter)[a]			
	95% Meteorology[b]		50% Meteorology[c]	
Receptor Location	Chlorine ERPG-1[d] = 3 (1) ERPG-2 = 9 (3) ERPG-3 = 60 (20)	Nitric Acid[e] TWA = 5.2 (2) LOC = 25.5 (10) IDLH = 255 (100)	Chlorine ERPG-1 = 3 (1) ERPG-2 = 9 (3) ERPG-3 = 60 (20)	Nitric Acid[e] TWA = 5.2 (2) LOC = 25.5 (10) IDLH = 255 (100)
1. Worker located at 100 meters (325 feet).	84,000 (28,000)	250 (95)	1,620 (540)	33 (13)
2. Nearest point of public access where a member of the public is assumed stranded at the time of the release.[f]	19.5 (6.5)	0.32 (0.12)	1.89 (0.63)	0.049 (0.019)
3. Maximally exposed hypothetical individual located at the nearest site boundary.[g]	4.2 (1.4)	0.12 (0.047)	0.42 (0.14)	0.016 (0.006)

a. Numbers in parentheses reflect concentrations in parts per million.
b. The 95 percentile meteorology is based on Class F (unfavorable) meteorological conditions with 0.5 meter per second (1.1 miles per hour) wind speed for receptors located within 2 kilometers (1.2 miles) of the release and 2 meters per second (4.5 miles per hour) for receptors beyond 2 kilometers of the release.
c. The 50 percentile meteorology is based on Class D (typical) meteorological conditions with 4.5 meters per second (10 miles per hour) wind speed for all receptors.
d. ERPG = Emergency Response Planning Guidelines.
e. Because Emergency Response Planning Guideline values are not available for nitric acid, time-weighted average values are substituted for ERPG-1 values, level of concern values are substituted for ERPG-2 values, and immediately dangerous to life or health values are substituted for Emergency Response Planning Guideline-3 values. Refer to Section 5.15.5.3 for further information regarding the use of these values.
f. The nearest point of public access from this postulated release is 5,870 meters (6,419 yards).
g. The nearest site boundary is located at 14,000 meters (15,310 yards).

Peak chlorine concentrations estimated at the nearest point of public access can exceed the Emergency Response Planning Guideline-2 value assuming 95 percentile meteorological conditions, as listed in Table 5.15-10. Symptoms associated with exposure to these concentrations could include burning of the eyes, nose, and throat, coughing, choking, and possibly skin burns.

As listed in Table 5.15-16, the estimated peak averaged chlorine concentration at the nearest site boundary would be above the Emergency Response Planning Guideline-1 value for 95 percentile meteorological conditions. However, due to the nature of the release, this concentration probably would not last for more than a few minutes. Therefore, it would be likely that individuals at this distance would experience no more than mild transient adverse health effects.

This analysis took limited credit for emergency response actions following a chlorine release in calculating the concentrations listed in Table 5.15-16. To mitigate the consequences of a chlorine release to the environment, the same emergency response programs and actions described for radiological accident scenarios (Section 5.15.4.1) would be initiated following the release. Therefore, actual health effects experienced by persons inside the site boundary would realistically be less than the values listed in Table 5.15-16.

Because the estimated airborne concentration of chlorine at 100 meters (328 feet) substantially exceeds the guidelines listed in Table 5.15-16, workers could be fatally injured or could receive long-term or permanent health effects. Potential secondary impacts associated with the chlorine accident scenario would involve economic impacts such as workers' compensation, medical bills, and potential lawsuits. No other secondary impacts, such as impacts on national defense or biotic resources, were identified.

5.15.5.3.2 Accidental Nitric Acid Release — Nitric acid is used at various spent nuclear fuel-related storage facilities for maintaining the chemistry of the water used in underwater storage facilities.[8] Based on the toxic chemical screening discussed in Section 5.15.5.1, review of existing safety analyses, walkdowns of spent nuclear fuel-related facilities, and interviews with INEL

8 Although bulk quantities of nitric acid would be required to perform processing activities that could be resumed under Alternatives 4b(1) and 5b, the consequences of processing-related accidents involving nitric acid would be bounded by the hydrofluoric acid and anhydrous accidents analyzed in Sections 5.15.5.3.3 and 5.15.5.3.4, respectively. Therefore, this analysis focuses on a potential nitric acid accident resulting from the non-processing spent nuclear fuel-related activities considered under the other alternatives.

personnel, DOE determined that the potential exists for an accidental release of nitric acid from one of two 1,135 liters (300-gallon) storage tanks used to support spent nuclear fuel-related water treatment activities at the Idaho Chemical Processing Plant. Because one of the tanks is usually empty, the two tanks have separate valves, and they are physically separated, DOE could not identify a reasonably likely initiator that could cause an accidental simultaneous release from both tanks.

The quantity of nitric acid assumed available for release from a single initiator would be (1,135 liters) 300 gallons. The following assumptions were made for this analysis:

- An initiating event causes severe structural damage (e.g., large puncture) to one of the tanks.
- The entire inventory of nitric acid is released into the containment wall surrounding the storage tank.
- The area of the containment wall is approximately 28 square meters (300 square feet).
- The total release of nitric acid [i.e., 1,135 liters (300 gallons)] evaporates into the atmosphere before the implementation of emergency response procedures can recover the nitric acid.

Table 5.15-16 summarizes the concentrations of the nitric acid release at the following receptor locations for both conservative (95 percentile) and average (50 percentile) meteorological conditions: a facility worker, a member of the public stranded at the nearest point of public access inside the INEL boundary, and a maximally exposed hypothetical member of the public at the nearest site boundary. The estimated frequency for this event is 1×10^{-5} events per year.

This analysis took limited credit for emergency response actions following a nitric acid release in calculating the concentrations listed in Table 5.15-16. To mitigate the consequences of a release to the environment, the same emergency response programs and actions described for radiological accident scenarios (Section 5.15.4.1) would be initiated following a nitric acid release. Therefore, actual health effects experienced by persons inside the site boundary would realistically be less than the values listed in Table 5.15-16.

Other than limited economic secondary impacts, no other secondary impacts would be likely if this accident occurred.

5.15.5.3.3 Accidental Hydrofluoric Acid Release — To resume spent nuclear fuel processing activities at the Fluorinel and Storage (FAST) facility (CPP-666), which is currently shutdown and being placed in a permanent shutdown mode, bulk quantities of hydrofluoric acid would be required to support the dissolution process. A hydrofluoric acid storage tank with an operating capacity of approximately 30,283 liters (8,000 gallons) is located in the Idaho Chemical Processing Plant facility area to support processing activities, although only 11,356 liters (3,000 gallons) of hydrofluoric acid remain in the tank, and efforts are currently underway to remove the remaining hydrofluoric acid in the tank from the INEL site.

Table 5.15-17 summarizes the potential impacts upon a maximally exposed hypothetically offsite individual located at the nearest site boundary [14,000 meters (15,310 yards)] resulting from a potential hydrofluoric acid release at the Idaho Chemical Processing Plant assuming 95 percentile meteorological conditions. Slaughterbeck et al. (1995) provides further details and discussion regarding this postulated accident scenario. Although Slaughterbeck et al. (1995) presents impacts to only the maximally exposed offsite hypothetical individual resulting from this postulated accident for 95 percentile meteorological conditions, a comparison of the airborne concentration of hydrofluoric acid at 14,000 meters (15,310 yards) to the airborne concentrations from other postulated chemical accident scenarios (as presented in Table 5.15-16) at the same receptor distance provides meaningful perspective on the significance of this accident.

Table 5.15-17. Summary of chemical concentrations for postulated processing-related accidental releases at the Idaho Chemical Processing Plant under Alternatives 4b(1) and 5b.

	Chemical Concentrations (milligrams per cubic meter)[a]	
	95% Meteorology[b]	
Receptor Location	Hydrofluoric Acid ERPG-1[c] = 4 (5) ERPG-2 = 17 (20) ERPG-3 = 43 (50)	Anhydrous Ammonia ERPG-1 = 17 (25) ERPG-2 = 136 (200) ERPG-3 = 680 (1000)
Maximally exposed hypothetical individual located at the nearest boundary[d]	0.078 (0.09)	82 (120.6)

a. Numbers in parentheses reflect concentrations in parts per million.
b. The 95 percentile meteorology is based on Class F (unfavorable) meteorological conditions with 0.5 meter per second (1.1 miles per hour) wind speed for receptors located within 2 kilometers (1.2 miles) of the release and 2 meters per second (4.5 miles per hour) for receptors beyond 2 kilometers of the release.
c. ERPG = Emergency Response Planning Guidelines.
d. The nearest site boundary is located at 14,000 meters (15,310 yards).

The estimated frequency for this event is 1×10^{-5} events per year. It should be noted that this potential accident applies only to Alternatives 4b(1) and 5b, and is in addition to the potential chlorine and nitric acid release accidents described in Sections 5.15.5.3.1 and 5.15.5.3.2, respectively.

This analysis took limited credit for emergency response actions following a hydrofluoric acid release in calculating the concentrations listed in Table 5.15-17. To mitigate the consequences of a release to the environment, the same emergency response programs and actions described for radiological accident scenarios (Section 5.15.4.1) would be initiated following a hydrofluoric acid release. Therefore, actual health effects experienced by persons inside the site boundary would realistically be less than the values listed in Table 5.15-17.

Other than limited economic secondary impacts, no other secondary impacts would be likely if this accident occurred.

5.15.5.3.4 Accidental Anhydrous Ammonia Release — To resume spent nuclear fuel processing activities at the Fluorinel and Storage (FAST) facility (CPP-666), bulk quantities of anhydrous ammonia would be required to support operation of the NO_x-Abatement Facility (CPP-1670), a facility that would be constructed to treat airborne effluents from the INEL processing facilities before being released to the environment.

The NO_x-Abatement Facility would be expected to utilize two anhydrous ammonia tanks, each with a storage capacity of 68,000 liters (18,000 gallons). Table 5.15-17 summarizes the potential impacts upon the maximally exposed hypothetical offsite individual located at the nearest site boundary [14,000 meters (15,310 yards)] resulting from a short-term release of the contents of both storage tanks [i.e., 136,000 liters (36,000 gallons)] at the Idaho Chemical Processing Plant assuming 95 percentile meteorological conditions. Slaughterbeck et al. (1995) provides further details and discussion regarding this postulated accident scenario. Although Slaughterbeck et al. (1995) presents only impacts to the maximally exposed offsite hypothetical individual resulting from this postulated accident for 95 percentile meteorological conditions, a comparison of the airborne concentration of anhydrous ammonia at 14,000 meters (15,310 yards) to the airborne concentrations from other postulated chemical accident scenarios (as presented in Table 5.15-16) at the same distance provides meaningful perspective on the significance of this accident.

The estimated frequency for this event is 5×10^{-6} events per year. The basis for this estimated frequency is identical to that described for an accidental chlorine release from two separate tanks, as described in Section 5.15.5.3.1. It should be noted that this potential accident applies only to Alternatives 4b(1) and 5b, and is in addition to the potential chlorine and nitric acid release accidents described in Sections 5.15.5.3.1 and 5.15.5.3.2, respectively.

This analysis took limited credit for emergency response actions following an anhydrous ammonia release in calculating the concentrations listed in Table 5.15-17. To mitigate the consequences of a release to the environment, the same emergency response programs and actions described for radiological accident scenarios (Section 5.15.4.1) would be initiated following a hydrofluoric acid release. Therefore, actual health effects experienced by persons inside the site boundary would realistically be less than the values listed in Table 5.15-17.

Other than limited economic secondary impacts, no other secondary impacts would be likely if this accident occurred.

5.15.6 Maximum Reasonably Foreseeable Radiological Accident Scenario Descriptions

The purpose of this section is to summarize the different accident scenarios identified in Section 5.15.4. The Facility Safety Report for the Argonne National Laboratory-West Hot Fuel Examination Facility (ANL 1975) contains further details and discussions for Accident 1, discussed below. Slaughterbeck et al. (1995) provides further details, discussions, and references for Accidents 2 through 7, discussed below. Additional discussions and references regarding the processing-related accidents summarized in this section are also provided in a study performed to determine the potential impacts spent nuclear fuel processing-related accidents could have on the siting of a new production reactor at the INEL (EG&G 1993b). These documents contain additional information, such as release fractions, source terms, and other assumptions used in the accident analyses. Appendix D describes postulated accident scenarios associated with Naval spent nuclear fuel-related facilities and activities at the INEL.

5.15.6.1 Accident 1: Fuel Pin Breach and Venting of Noble Gases and Iodine to the Environment from a Mechanical Handling Accident at the Argonne National Laboratory-West Hot Fuel Examination Facility. The accident screening methodology discussed in Section 5.15.3 identified a mechanical handling event at the Argonne National Laboratory-West Hot Fuel Examination Facility as an initiator to the maximum reasonably foreseeable accident within the abnormal event frequency range. This event would result in a fuel pin breach and venting of noble gases and iodine to the environment. The identification of this accident as a maximum reasonably

foreseeable accident is based on the estimated radiological consequences to the maximally exposed hypothetical offsite individual at the nearest site boundary presented in the Hot Fuel Examination Facility Safety Report (ANL 1975). Other postulated accidents associated with handling spent nuclear fuel in the Hot Fuel Examination Facility before the identification of the fuel pin breach accident as the maximum reasonably foreseeable accident included an inadvertent criticality and a sodium fire. A fuel pin breach accident was chosen as the maximum reasonably foreseeable accident because the estimated frequencies for an inadvertent criticality and a sodium fire in the facility are extremely low (ANL 1975).

The analyses defined in the Facility Safety Report (ANL 1975) made the following assumptions:

- The fuel subassemblies and experimental capsules being examined in the facility were cooled for at least 15 days to ensure that the short-lived fission products had decayed.

- The noble gases and iodines that could be released from this accident scenario were immediately released.

- One hundred percent of the noble gases, 25 percent of the iodines, and 1 percent of particulates were available for escape to the atmosphere.

- The building containment structure, including the building ventilation system, and the Main Cell, including the argon ventilation system, remained operational following the handling accident. This assumption is considered appropriate because the mechanical handling accident scenario under consideration would not initiate a failure in these systems. (Accident 3 considers the simultaneous failure of all these systems in conjunction with the melting of fuel assemblies stored in the facility).

The Facility Safety Report (ANL 1975) contains specific information on the source terms associated with breaching the fuel section of a pin. Because that report does not provide an estimated frequency of occurrence for the subject mechanical handling accident scenario, the analysis used historic information and engineering judgment to determine the conservatively estimated frequency for this accident of 1.0×10^{-2} event per year.

For determining the impacts from this postulated accident scenario, the nearest point of public access is equivalent to the nearest site boundary, which is 5,240 meters (5,730 yards) from the point of the release. Although the Facility Safety Report (ANL 1975) does not estimate consequences to the offsite population resulting from this accident scenario, this analysis reasonably estimated that the exposures (i.e., dose) to the offsite population would be less than the offsite population dose calculated for Accidents 2 through 4 because the dose to the maximally exposed hypothetical individual at the nearest site boundary from this accident would be less than that estimated for Accidents 2 through 4.

5.15.6.2 Accident 2: Inadvertent Nuclear Chain Reaction in Wet Spent Nuclear Fuel Storage (1 × 10^{19} fissions, 8-hour release) at the Idaho Chemical Processing Plant CPP-603 Underwater Fuel Storage Facility. The accident screening methodology discussed in Section 5.15.3 identified an inadvertent nuclear criticality associated with underwater spent nuclear fuel storage at the CPP-603 Underwater Fuel Storage Facility as an accident requiring further evaluation. Other postulated accidents that were considered before the identification of an inadvertent criticality accident as a maximum reasonably foreseeable accident included pool leaks, fuel damage events, and loss of cooling events. This analysis selected an inadvertent nuclear criticality for evaluation in this EIS over the other accidents for the following reasons:

- Postulated inadvertent nuclear criticality accidents have been addressed in virtually all DOE nonreactor EISs and safety analysis reports in which such accidents were reasonably foreseeable because of public concerns regarding the potential for these accidents.

- The Idaho Chemical Processing Plant has experienced three inadvertent nuclear criticality accidents. Although none of these accidents involved a fuel storage facility, they demonstrate the potential and concern for such events.

- The consequences of water leakage from a pool-draining event would present lower prompt consequences to workers than a criticality because the INEL could implement emergency response plans to evacuate workers before the risk to these workers could substantially increase. In addition, a pool drain was considered to be an initiator to a criticality accident.

- Mechanical fuel damage events are less impacting than a nuclear chain reaction scenario because some degree of fuel damage is part of the criticality accident scenario and analysis.

Of the different Idaho Chemical Processing Plant facility areas that store spent nuclear fuel, the CPP-603 Underwater Fuel Storage Facility was selected for analysis of a criticality accident for the following reasons:

- CPP-603 facility storage includes most types of spent nuclear fuel stored elsewhere on the site. Fuel stored at reactor basins is an exception (but was considered in the determination of other reasonably foreseeable accident scenarios) because of its much shorter cooling times after removal from a reactor.

- CPP-603 facility spent nuclear fuel storage quantities are comparable to or exceed the spent nuclear fuel inventories stored elsewhere on the site.

- The CPP-603 facility is an older facility that does not contain all the preventive or mitigative design features found in more modern facilities, such as the CPP-666 Fuel Storage Area.

The analysis selected the underwater fuel storage portion of the CPP-603 facility rather than the Irradiated Fuels Storage Facility portion of the CPP-603 facility because accidents involving graphite fuels in dry storage probably would have less severe potential consequences because they had been removed from reactors for a much longer period of time and, because of their design, would prevent most of the remaining fission products from being released if a criticality accident occurred.

Initiating events that the analysis considered possible to lead to an inadvertent nuclear criticality included operator error, hanger corrosion, equipment failure, an earthquake, pool drain, and an aircraft crash. The scenario discussed in this EIS assumes a postulated criticality scenario that could be initiated by human error, equipment failure, or earthquake. Heat generated from the chain reaction would easily dissipate and thereby avoid fuel melting but would still cause the release of fission products associated with 1 × 10^{19} fissions over an 8-hour period.

Between 1945 and 1980, 40 known inadvertent criticalities occurred worldwide, none of which involved the handling or storage of spent nuclear fuel in an underwater fuel storage facilities. In addition, between 1975 and 1980, there were 160 nuclear power reactor facilities with underwater fuel storage facilities worldwide. None of these facilities ever had a nuclear criticality associated with its underwater storage facilities. Therefore, it is generally assumed that the likelihood for such an event in a modern underwater storage facility is unlikely, with a frequency estimated at 1 × 10^{-4} event per year. This estimated frequency is supported by information in the safety analysis report for the CPP-666 underwater storage facility, which is a modern facility (e.g., 1980s vintage) at the INEL used to store various types of spent nuclear fuel. In the CPP-603 Underwater Fuel Storage Facility, however, where spent nuclear fuel inventories have substantially corroded or degraded (DOE 1993c), and where the design of the facility and its supporting equipment do not meet current design specifications, activities associated with handling and storing spent nuclear fuel present an increase in the likelihood for an inadvertent nuclear criticality accident by as much as an order of magnitude. Therefore, this analysis conservatively assumes the estimated frequency for an inadvertent nuclear criticality associated with handling spent nuclear fuel in the CPP-603 Underwater Fuel Storage Facility to be 1×10^{-3} event per year for this analysis.

The handling activities associated with stabilizing CPP-603 facility spent nuclear fuel inventories would occur under each of the five alternatives considered in this EIS. The estimated frequency for an inadvertent criticality at the CPP-603 facility is an order of magnitude larger than that of any other INEL facility (e.g., 1×10^{-3} event per year), and is considered a "worst-case" frequency that bounds changes in estimated criticality frequencies at other INEL facilities resulting from increased handling activities associated with changes in spent nuclear fuel inventories. Therefore, using the estimated criticality frequency related to the CPP-603 as the estimated frequency under each alternative provides a conservative bound on the estimated criticality frequencies for other spent nuclear fuel-related handling and storage facilities.

To determine the accident impacts from this postulated accident scenario, the analysis assumed the worker to be located 100 meters (328 feet) from the event, the nearest point of public access (U.S. Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is located at 14,000 meters (15,310 yards).

5.15.6.3 Accident 3: Earthquake-Induced Breach and Fuel Melt at the Argonne National Laboratory-West Hot Fuel Examination Facility. The accident screening methodology discussed in Section 5.15.3 identified an earthquake-induced breach and fuel melt at the Argonne National Laboratory-West Hot Fuel Examination Facility as a maximum reasonably foreseeable accident that would present higher radiological consequences to facility workers or the

offsite population than other postulated accidents analyzed in the same accident frequency range. The postulated events leading to atmospheric release of radionuclides are as follows:

- The earthquake results in a peak horizontal ground acceleration of sufficient magnitude to cause structural damage to the building structure and a large breach in the main cell.[9]

- Coincident with the breach, a failure of the fuel subassembly cooling system occurs, resulting in the melting of fresh assemblies.

- Radionuclides from the melting fuel subassemblies are released to the atmosphere.

The estimated probability of an earthquake in the Argonne National Laboratory-West facility area resulting in a peak horizontal acceleration of sufficient magnitude to damage the facility structure and breach the cell is 1×10^{-5} event per year. This analysis conservatively assumes the probability of failure of the building structure, Main Cell, and subassembly cooling to be 1.0, given that the earthquake has occurred. A preliminary assessment of the seismic integrity of the Hot Fuel Examination Facility, as discussed in Slaughterbeck et al. (1995), indicates that, given the current state of analysis, significant failures could result at the Hot Fuel Examination Facility from this earthquake.

In determining the number of fuel assemblies that would be affected during this scenario, the analysis assumed that 20 fuel subassemblies would melt due to failure of the forced cooling in this accident. Although 40 storage positions are available for fuel that would require forced cooling, current plans do not estimate the need to use more than 20 of these positions. The release duration for this scenario is 30 days. To prevent doses greater than 5 rem to the public from this scenario, the analysis assumed intervention by evacuation or prevention of contaminated food consumption, with the calculated doses reflecting this assumption.

To determine the impacts from this postulated accident scenario, the analysis assumed the worker to be located 100 meters (328 feet) from the event, and the nearest point of public access (U.S. Route 20) and the nearest site boundary at 5,240 meters (5,730 yards).

9 As discussed in Slaughterbeck et al. (1995), accelerations with any of several potential seismic events with a combined estimated frequency of 1×10^{-5} per year are beyond the design of the Hot Fuel Examination Facility and were determined to compromise the ability of the structure to maintain confinement. Events this rare are beyond the requirements of DOE Order 5480.28 and DOE-ID Architectural Engineering Standards for Category 1 (high hazard) facilities.

5.15.6.4 *Accident 4: Radiological Material Release from the Argonne National Laboratory-West Hot Fuel Examination Facility Resulting from an Aircraft Crash and Ensuing Fire.* The accident screening methodology discussed in Section 5.15.3 identified a radioactive material release from the Argonne National Laboratory-West Hot Fuel Examination Facility resulting from an aircraft crash as the maximum reasonably foreseeable accident in the beyond-design-basis accident frequency range. Of externally initiated events, an aircraft crash into the Hot Fuel Examination Facility is a maximum reasonably foreseeable accident because it could (1) cause a major breach of confinement barriers, (2) involve a large portion of the material at risk, and (3) have a high-energy release mechanism (physical impact followed by a sustained fire). The analysis eliminated other accident scenarios considered in this frequency range because they would not have sufficient energy sources to cause a large breach of confinement and release to the atmosphere. Although the facility contains little combustible material to sustain a fire, a fire caused by aircraft fuel involved in the crash could increase potential consequences over other beyond-design-basis accidents. The major events of an aircraft crash scenario are as follows:

- A large or high-velocity aircraft (e.g., commercial or military) crashes directly into the Hot Fuel Examination Facility.
- The impact has sufficient force to cause catastrophic failure of the building structure, breach of the Main Cell, and loss of forced cooling to subassemblies in the cell.
- The fuel in the aircraft is released to the facility and is ignited.
- The ensuing fire involves the contents of the Main Cell, Decontamination Cell, High Bay Area, and Hot Repair Area, resulting in atmospheric release of radionuclides.

To determine aircraft crash probability, the analysis limited this scenario to large or high-velocity jet airplanes. High-velocity military jets from the U.S. Air Force Base at Mountain Home in southwestern Idaho could enter the airspace of the INEL. In addition, large jet aircraft have been flown at low altitudes in landing configurations over portions of the INEL for vortex tests. The likelihood of a large aircraft crash directly in the Hot Fuel Examination Facility is remote, but possible. Analyses of jet aircraft crashes at specific facilities, such as the Idaho Chemical Processing Plant, have resulted in predicted frequencies on the order of 1.0×10^{-7} event per year. Because specific analyses have not determined the likelihood of an aircraft crash into the Hot Fuel Examination Facility (although it is expected that fewer flights occur over the Argonne National Laboratory-West

facility area than the Idaho Chemical Processing Plant), the analysis conservatively assumed that the frequency for an aircraft crashing into the Hot Fuel Examination Facility is 1.0×10^{-7} per year.

For determining impacts from this postulated accident scenario, the analysis assumed the worker was located 100 meters from the event; and the nearest point of public access (U.S. Route 20) and the nearest site boundary were both at 5,240 meters (5,730 yards).

5.15.6.5 *Accident 5: Inadvertent Nuclear Chain Reaction During Spent Nuclear Fuel Processing (1×10^{19} fissions) at the Idaho Chemical Processing Plant CPP-666 Fluorinel and Storage (FAST) Facility.* The accident screening methodology discussed in Section 5.15.3 identified an inadvertent nuclear criticality resulting from spent nuclear fuel reprocessing in the CPP-666 Fluorinel and Storage Facility as a maximum reasonably foreseeable processing accident. Although the CPP-666 Fluorinel and Storage Facility, which historically reprocessed spent nuclear fuel to recover fissionable radionuclides (e.g., uranium-235), is currently shutdown, there may be a need to resume processing operations to dissolve spent nuclear fuel and to stabilize the radionuclides in a waste form. Therefore, while the potential for this accident does not currently exist, the potential would exist if processing-related activities are resumed under Alternatives 4b(1) and 5b (Regionalization and Centralization at the INEL, respectively).

Initiating events that the analysis considered possible to lead to an inadvertent nuclear criticality during processing included human error, equipment failure, an earthquake, an aircraft crash, excessive fissionable radionuclides in the spent nuclear fuel being processed, and reduced neutron poison concentrations. Consistent with the inadvertent criticality scenario associated with underwater storage of spent nuclear fuel described in Section 5.15.6.2, the fission yield associated with this criticality was assumed to be 1×10^{19} fissions. Further information and references regarding this postulated accident scenario are provided in Slaughterbeck et al. (1995) and EG&G (1993b).

As discussed in Section 5.15.2, three inadvertent nuclear criticalities have occurred in INEL processing facilities during the 40-year history of the INEL. The last of these criticalities occurred 14 years ago. As a result of these accidents, administrative controls and facility modifications were implemented to reduce the potential for inadvertent nuclear criticality accidents resulting from processing-related activities. If the decision is made to resume processing operations, these same controls would be utilized. Therefore, the estimated frequency for a potential inadvertent nuclear criticality is assumed to be 1×10^{-3} events per year, which is consistent with assumptions made regarding the potential for an inadvertent criticality resulting from underwater storage and handling of severely degraded spent nuclear fuel (as discussed in Section 5.15.6.2).

Limited credit was taken for mitigative features, such as emergency response programs, in determining worker and public exposures resulting from this postulated accident scenario. However, credit was taken for shielding walls placed in the facility to reduce potential personnel exposures resulting from an inadvertent nuclear criticality.

To determine the accident impacts from this postulated accident scenario, the analysis assumed the worker to be located 100 meters (328 feet) from the event, the nearest point of public access (U.S., Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is located at 14,000 meters (15,310 yards).

5.15.6.6 Accident 6: Radionuclide Release During Spent Nuclear Fuel Processing at the Idaho Chemical Processing Plant CPP-666 Fluorinel and Storage (FAST) Facility Resulting from a Hydrogen Explosion in the Dissolver Off-Gas System. The accident screening methodology discussed in Section 5.15.3 identified a hydrogen explosion in the CPP-666 Fluorinel and Storage Facility dissolver off-gas system as a maximum reasonably foreseeable processing accident. Despite CPP-666's current shutdown status, there may be a need to resume processing operation to dissolve spent nuclear fuel and stabilize the radionuclides in a waste form. Therefore, while the potential for this accident does not currently exist, the potential would exist if processing-related activities are resumed under Alternatives 4b(1) and 5b (Regionalization and Centralization at the INEL, respectively).

Initiating events that the analysis considered possible to lead to a hydrogen explosion in the dissolver off-gas system included human error, equipment failure, and an earthquake. Further information and references regarding this postulated accident scenario are provided in Slaughterbeck et al. (1995) and EG&G (1993b).

Limited credit was taken for mitigative features, such as emergency response programs, in determining worker and public exposures resulting from this postulated accident scenario. To determine the accident impacts from this postulated accident scenario, the analysis assumed the worker to be located 100 meters (328 feet) from the event, the nearest point of public access (U.S., Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is located at 14,000 meters (15,310 yards).

5.15.6.7 Accident 7: Radionuclide Release During Spent Nuclear Fuel Processing at the Idaho Chemical Processing Plant CPP-666 Fluorinel and Storage (FAST) Facility Resulting from the Inadvertent Dissolution of 30-Day Cooled Spent Nuclear Fuel. The accident screening methodology discussed in Section 5.15.3 identified a radionuclide release resulting from the inadvertent dissolution of 30-day cooled spent nuclear fuel in the CPP-666 Fluorinel and Storage Facility as a maximum reasonably foreseeable accident. There may be a need to resume processing operation at CPP-666 to dissolve spent nuclear fuel and stabilize the radionuclides in a waste form. Therefore, while the potential for this accident does not currently exist, the potential would exist if processing-related activities are resumed under Alternatives 4b(1) and 5b (Regionalization and Centralization at the INEL, respectively).

Upon removal from a nuclear reactor, spent nuclear fuel is placed in an underwater storage canal (e.g., Advanced Test Reactor Storage Canal in the Test Reactor Area) to allow the fuel temperature to cool and short-lived radionuclides to decay. Inadvertent processing of spent nuclear fuel that has not had the opportunity to sufficiently cool presents the potential for accidents during dissolution of the fuel. Examples of accidents that could potentially occur are explosions in the dissolver tank and an inadvertent criticality. An explosion resulting from inadvertent dissolving spent nuclear fuel that has not sufficiently cooled (i.e., 30-day cooled fuel) is considered for this analysis since an inadvertent criticality is already considered (as discussed in Section 5.15.6.6).

The potential initiating event considered for this accident involves several operator errors that result in the wrong spent nuclear fuel assemblies being dissolved. First, fuel cooled 30 or fewer days would have to be shipped to and received by the Fluorinel and Storage Facility. Second, operators at the CPP-666 Fluorinel and Storage Facility would have to inadvertently dissolve the 30-day (or fewer) cooled fuel. Based on the individual probability of these events, and the probability that the dissolved fuel would accidentally release radionuclides to the environment, the estimated frequency for this event is 1×10^{-6} events per year. Further information and references regarding this postulated accident scenario are provided in Slaughterbeck et al. (1995) and EG&G (1993b).

Limited credit was taken for mitigative features, such as emergency response programs, in determining worker and public exposures resulting from this postulated accident scenario. To determine the accident impacts from this postulated accident scenario, the analysis assumed the worker to be located 100 meters (328 feet) from the event, the nearest point of public access (U.S., Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is located at 14,000 meters (15,310 yards).

5.16 Cumulative Impacts and Impacts from Connected or Similar Actions

The INEL already contains major DOE facilities unrelated to spent nuclear fuel that would continue to operate throughout the life of the spent nuclear fuel management program. The activities associated with these existing facilities produce environmental consequences that this EIS has included in the baseline environmental conditions (Chapter 4) against which it has assessed the consequences of the spent nuclear fuel alternatives. In addition, the cumulative impacts assessed in this section include other past, present, and reasonably foreseeable future actions that DOE expects to occur at the INEL, such as spent nuclear fuel management, Naval Nuclear Propulsion Program activities, environmental restoration and waste management activities, as well as any known offsite projects conducted by government agencies, businesses, or individuals. Onsite projects include decontamination and decommissioning, repair, and upgrades of existing facilities. Offsite projects include residential and commercial development, and changes in manufacturing plants.

Consistent with the DOE sliding scale approach and the programmatic aspects of this EIS, cumulative impacts are discussed commensurate with the degree of impact. Therefore, not every area of analysis from Chapter 5 is represented in this section. DOE used information and analyses from Volume 2 of this EIS as input for this section. Section 5.15 of Volume 2 provides a more detailed discussion of cumulative impacts.

Tables 5.16-1 and 5.16-2 list the cumulative impacts identified for each alternative. DOE made necessary adjustments to accommodate the differences between Volume 1 and Volume 2 alternatives. Cumulative impacts from Alternatives 3 and 4a are nominally the same, as are cumulative impacts from Alternatives 1 and 2, 5a and 4b(2), and 5b and 4b(1).

5.16.1 Land Use

Implementation of any of the alternatives would contribute to the cumulative loss of land with open-space land use. However, the cumulative amount of land that would no longer be open space or available for other land uses would be small compared to the size of INEL or regional land uses. As discussed in Section 5.2, Land Use, the maximum land disturbance, 31 acres (0.12 square kilometer) would occur under Alternative 4b(l) [Regionalization by Geography (INEL)] and 5b (Centralization at INEL). While exact maximum figures are not available, over 200 acres (0.81 square kilometer) of vacant land in nearby communities are scheduled for development. Projects that would potentially

Table 5.16-1. Nonhealth-related cumulative impacts.

Discipline/Unit of measure		1 (No Action) and 2 (Decentralization)	3 (1992/1993 Planning Basis) and 4a (Regionalization by Fuel Type)	5a (Centralization at Other Sites) and 4b(2) [Regionalization by Geography (Elsewhere)]	5b (Centralization at INEL) and 4b(1) [Regionalization by Geography (INEL)]	Comments
Land use/amount of land not available for other use		Small compared to regional land uses	Small compared to regional land uses	Small compared to regional land uses	Small compared to regional land uses	
Socioeconomics/change in number of total jobs		Overall decrease of 4,800	Overall decrease of 2,300	Overall decrease of 4,400	Overall decrease of 1,400	Under all alternatives, additional jobs created would be more than offset by decrease from other actions
Cultural resources/minimum number of potentially historic structures/archaeological sites disturbed[a]		6 structures and 0 sites	70 structures and 22 sites	11 structures and 0 sites	70 structures and 22 sites	Under all alternatives, the potential for reduction of the number of cultural resources exists
Air resources[b]		Below applicable standards	Below applicable standards	Below applicable standards	Below applicable standards	
Waste management/waste volume total pending disposition	High-level[d]	12,100 m^3	12,500 m^3	17,000 m^3	12,100 m^3	These volumes reflect existing and newly generated wastes pending disposition under each alternative
	Transuranic[c]	67,000 m^3	73,000 m^3	67,000 m^3	87,000m^3	
	Mixed low-level	17,000 m^3	17,000 m^3	17,000 m^3	167,000 m^3	
	Low-level[e]	46,000 m^3	72,000 m^3	47,000 m^3	840,000 m^3	
	Hazardous[f]	12,000 m^3	12,000 m^3	12,000 m^3	12,000 m^3	
	Commercial and industrial[e]	540,000 m^3	590,000 m^3	550,000 m^3	590,000 m^3	

a. Numbers for archaeological sites potentially impacted would be expected to increase as cultural resource surveys are conducted for projects on acreage previously unsurveyed.

b. See Table 5.16-2 for cumulative health risks related to air emissions.

c. Derived in Freund (1994), Morton and Hendrickson (1995).

d. High-level waste includes both liquid and calcine forms. Liquid high-level waste totals do not include processing, which would increase these reported totals by some degree. Numbers represent total volume of all high-level waste stored onsite.

e. Numbers do not include existing dispositioned waste stored or buried onsite.

f. Numbers represent total volume stored onsite.

Table 5.16-2. Health-related cumulative impacts.

Radiological[a]	Pathway	Type of impact	1 (No Action) and 2 (Decentralization)	3 (1992/1993 Planning Basis) and 4a (Regionalization by Fuel Type)	5a (Centralization at Other Sites) and 4b(2) [Regionalization by Geography (Elsewhere)]	5b (Centralization at INEL) and 4b(1) [Regionalization by Geography (INEL)]	Comments
Public	Atmoshperic	Estimated excess fatal cancers	<1	<1	<1	<1	
	Groundwater	Estimated excess fatal cancers	<1	<1	<1	<1	
	Biotic	Estimated excess fatal cancers	<1	<1	<1	<1	This pathway would involve harvesting game animals and vegetation that can assimilate radioactivity onsite.
Workers[b]	Atmospheric	Estimated excess fatal cancers	Negligible	Negligible	Negligible	Negligible	Overall cancers expected to be less than baseline because fewer employees under all alternatives.
	Occupational exposures	Estimated excess fatal cancers	1	1	1	1	
Public	Atmospheric (Carcinogens)	Estimated lifetime cancers	<1	<1	<1	<1	
	Atmospheric (Noncarcinogens)[c]	Estimated adverse health effects	0	0	0	0	

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Table 5.16-2. (continued).

Radiological[a]	Pathway	Type of impact	1 (No Action) and 2 (Decentralization)	3 (1992/1993 Planning Basis) and 4a (Regionalization by Fuel Type)	5a (Centralization at Other Sites) and 4b(2) [Regionalization by Geography (Elsewhere)]	5b (Centralization at INEL) and 4b(1) [Regionalization by Geography (INEL)]	Comments
Workers[b]	Atmospheric (Carcinogens)	Estimated lifetime cancers	<1	<1	<1	<1	
	Atmospheric (Noncarcinogens)[c]	Estimated adverse health effects	0	0	0	0	
	Routine workplace safety hazards	Estimated fatalities	3	3	3	3	Estimates differ only slightly between alternatives due to changes in number of workers. Total workplace safety hazards are fewer than those encountered by the average worker in private industry.

a. Approximate numbers. See Volume 2, Section 5.12 and Volume 2, Appendix F for detailed discussion and analyses.
b. Estimated excess fatal cancers calculated from dosimeter measurements.

disturb previously disturbed land are scheduled to take place on about 270 acres (1.0 square kilometer) at the INEL. An additional 1,060 acres (4.3 square kilometers) of open space INEL land may also be disturbed by potential projects.

5.16.2 Socioeconomics

Any of the spent fuel management alternatives would cause minimal cumulative impacts on socioeconomic resources of the INEL region when combined with known onsite or offsite projects. The implementation of any of the alternatives would create temporary additional employment during construction; the upper bound of potential impact would occur under Alternatives 3, 4a, 4b(1), and 5b. In the long term, the expected future decrease in employment at the INEL would more than offset this increase, as well as any increases from known offsite projects. Therefore, the cumulative effect on employment would be an overall decrease. Potential population declines associated with the cumulative effect on regional employment are estimated to represent less than 2 percent of the total regional population. It is unlikely that a change in population of this size would generate any notable long-term adverse impacts to housing, community services, or public finance in the region.

5.16.3 Cultural Resources

The types of cumulative impacts on cultural resources are the same for all alternatives. Each of the alternatives, when combined with associated onsite and offsite activities, could potentially impact cultural resources. However, surveying, recording, and stabilizing archeological and historic sites and structures at the INEL would increase scientific knowledge of the region's cultural resources, although stabilizing resources may adversely affect their significance to Native American groups. The unchecked deterioration of both structures and historic documents on nuclear facilities at the INEL could have a long-term adverse impact on these resources. Long-term effects may also occur to traditional resources that may not be mitigated through scientific studies. Cumulative impacts associated with Alternatives 3 and 4a (see 1992/1993 Planning Basis and Regionalization by Fuel Type) and Alternatives 5b and 4b(1) [Centralization at INEL and Regionalization by Geography (INEL)] have the greatest potential for impacts. Alternatives 1 and 2 (No Action and Decentralization) would have the least potential for impacts.

5.16.4 Air Quality

For radiological emissions, all cumulative impacts at onsite and offsite locations are well below applicable standards and are a small fraction of the dose received from natural background sources. The highest dose to a maximally exposed member of the public would be caused by Alternatives 4b(l) and 5b and would be about 0.05 millirem per year. When added to the projected dose from other INEL proposed projects of approximately 0.7 millirem per year and the maximum baseline dose of 0.05 millirem per year, this dose would be well below the National Emissions Standards for Hazardous Air Pollutants limit of 10 millirem per year (CFR 1992c). The National Council on Radiation Protection and Measurements has identified a dose rate below 1 millirem per year as negligible (NCRP 1987).

Cumulative nonradiological impacts were analyzed in terms of concentrations of criteria and toxic air pollutants in ambient air. At site boundary locations, the highest potential concentrations of criteria pollutants remain well below applicable National Ambient Air Quality Standards (CFR 1991). Concentrations at public road locations within the INEL boundary could increase significantly from current levels, but would remain well below applicable standards.

5.16.5 Occupational and Public Health and Safety

Work activities and the exposure to radiological and chemical hazards under each of the alternatives would be similar to those at present. Therefore, average radiation dose, exposure to toxic chemicals, and associated health effects would be related to the number of site workers under each alternative. Because the cumulative impacts of any alternative would be a decrease in the number of workers, the cumulative impact of any alternative on occupational health would be a decrease in health effects to the levels listed in Table 5.16-2. The incidence of expected health effects would be similar for all alternatives because the relative difference in employment effects (and therefore the effects on the health of those employed) is very small. While air emissions present the only calculable pathway for public radiation exposure due to spent nuclear fuel management, groundwater and biotic pathways are included in Table 5.16-2 due to Volume 2 analyses of environmental restoration and waste management activities.

Occupational health data concerning historic accidents are incomplete and not readily available. Though historical records of accidents at the INEL are available, occupational doses were not always known and reported. Worker dose data are currently being collected and analyzed under a National

Institute of Occupational Safety and Health program. Historical offsite doses associated with the INEL are summarized in the Idaho National Engineering Laboratory Historical Dose Evaluation (DOE 1991). The Centers for Disease Control and Prevention is conducting a more comprehensive reconstruction of doses from INEL operations. An assessment of the cumulative impacts of accidents at the Site to the health of INEL workers is not available at this time.

Cumulative transportation impacts are addressed in Volume 1, Appendix I.

5.16.6 Materials and Waste Management

The total volumes of waste existing and projected to be generated or shipped to the INEL from spent nuclear fuel management, as well as known onsite and offsite projects over a 10-year period, are presented by waste stream for each alternative in Table 5.16-1. The storage of low-level waste for incineration is not considered to be restrictive between 1995 and 2005; however, beyond 2005 additional capacity may be required. Although spent nuclear fuel management would not cause permitted storage capacity to exceed its limits without available treatment or disposal under the No Action and Decentralization Alternatives, it is anticipated that the permitted storage capacity for mixed low-level waste will be exceeded during the first year of a 10-year timeframe. All other alternatives include facility construction for storage of, or shipping of, mixed low-level waste; therefore, storage capacity is accounted for.

5.17 Adverse Environmental Effects That Cannot Be Avoided

The construction and operation of any of the alternatives at the INEL could result in adverse impacts to the environment. Changes in project design and other measures would avoid or otherwise mitigate most of these impacts to minimal levels. This section identifies only adverse impacts that mitigation could not reduce to minimal levels or avoid altogether.

Under each alternative, the continued deterioration of structures with historic preservation potential and historic documents on nuclear facilities could have a long-term adverse impact on these resources at the INEL. However, DOE would avoid potentially adverse impacts by preserving the historic value of the property through appropriate research, or by conducting limited rehabilitation on these structures. This impact is discussed in Section 5.4.

As discussed in Section 5.2, the maximum loss of habitat would involve the conversion to industrial use of about 31 acres (0.12 square kilometers) of previously disturbed habitat that is of low quality and limited use to wildlife; conversion would occur under Alternatives 4b(1) and 5b.

The amount of radiation exposure from normal operation of the spent nuclear fuel facilities would be a small fraction of the existing natural background at the INEL and would be well below applicable regulatory standards. In all cases, the number of estimated additional cancers is a small fraction of 1 per year of site operation through 2035. This effect is discussed in Section 5.12.

With the exception of the unavoidable temporary increase in noise due to construction activities, any impact of noise from activities under any of the alternatives would be minor and highly unlikely.

An unavoidable adverse impact of the proposed activities with any of the alternatives would be an accident either at the involved facilities or during the transportation of construction materials or dismantled components. Accidents are discussed in Section 5.15; transportation is discussed in Section 5.11.

Spent nuclear fuel management supports the continuation of beneficial activities such as radiopharmaceutical and other research. An unavoidable adverse impact of the No-Action Alternative would be a reduction in the support of such activities.

As discussed in Section 5.14, the increased generation of industrial solid waste that would occur under all alternatives is an unavoidable adverse impact. However, the amount generated under each alternative would be a very small percentage increase from the projected 1995 baseline levels.

5.18 Relationship Between Short-Term Use of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Under all alternatives, short-term use of the environment is generally associated with resource demands for spent nuclear fuel management activities. Resources demands also include those required for upgrade, construction, and operation of facilities. These short-term demands and uses provide a foundation and direction for the long-term productivity of INEL; they also have an effect on the success of future INEL missions. A brief discussion of the influence proposed actions would have on the long-term productivity of the INEL follows. The INEL missions, including spent nuclear fuel, are discussed in Section 2.1.

The No-Action Alternative would provide few long-term benefits and would not allow DOE-Idaho Operations Office to fulfill its missions regarding the disposition and management of spent nuclear fuel. The activities proposed in this alternative would not support future proposals for disposal technology development. Further, the No-Action Alternative could bring enforcement actions because it would not meet all the requirements of existing DOE regulatory commitments such as those outlined in the Federal Facility Agreement and Consent Order.

To a varying degree, Alternatives 2, 3, and 4(a) would provide more flexibility than other alternatives for fulfilling existing or future missions and actions at INEL. Near- and long-term actions under these alternatives ensure compliance with regulatory requirements and protection of the environment. Furthermore, these alternatives would provide a diverse decisionmaking platform for future actions concerning disposition of DOE spent nuclear fuel. Facilities constructed and technologies developed under these alternatives could be used for a wide range of activities such as interim treatment and storage or preparation and packaging for transportation offsite.

The approach that would be taken for spent nuclear fuel under Alternatives 4b(2) and 5a could confine and hinder long-term productivity at INEL. Efforts would focus on shipment of spent nuclear fuel to other locations. No emphasis would be placed on solving particular spent nuclear fuel disposal problems or increasing the understanding of how certain spent nuclear fuels react over time.

Alternatives 4b(1) and 5b would direct INEL's future mission and development primarily toward large-scale canning and characterization, storage, and disposal of all INEL and DOE regional or complex-wide spent nuclear fuel. These alternatives could limit INEL's flexibility in redirecting or enhancing future INEL-specific missions.

5.19 Irreversible and Irretrievable Commitment of Resources

The irreversible and irretrievable commitment of natural and manmade resources resulting from the construction and operation of facilities related to the spent nuclear fuel alternatives would involve materials and resources that could not be recovered or recycled or that would be consumed or reduced to unrecoverable forms. Some of these commitments would be irretrievable because of the nature of the commitment or the cost of reclamation. For example, the construction and operation of spent nuclear fuel facilities at the INEL would consume irretrievable amounts of electrical energy, fuel, concrete, steel, aluminum, copper, plastics, lumber, sand, gravel, groundwater, and miscellaneous chemicals.

Alternatives 4b(1) and 5b are each estimated to require approximately 11,000 megawatt-hours per year of electricity, 1,100,000 liters (290,000 gallons) per year of fuel oil, and 48 million liters (13 million gallons) per year of water above the projected baseline (1995) usage of these resources (see Section 5.13). These changes would represent a modest increase of 5.3 percent, 9.9 percent, and 0.7 percent respectively, and are well within current system capabilities and usage limits. All other alternatives would place smaller demands on these resources, commensurate with the level of construction and operation activities proposed.

Alternatives 4b(1) and 5b would also commit 31 acres (0.12 square kilometer) of previously disturbed land to industrial use; the conversion of this acreage would result in the commitment of poor quality wildlife habitat and natural resource services. Alternatives 4b(1) and 5b would involve the greatest irretrievable consumption of other resources, such as construction materials and operating supplies. However, this demand would not constitute a permanent drain on local resources or involve any material that is in short supply in the region.

Other commitments would be irreversible because the construction or operation of facilities related to the spent nuclear fuel alternatives would consume the resource. Proposed activities would also require an expenditure of labor that would be irretrievable.

5.20 Potential Mitigation Measures

This section summarizes measures that DOE would use to avoid or reduce impacts to the environment caused by spent nuclear fuel management activities at the INEL. The potential mitigation measures for each aspect of the affected environment described below are the same under each alternative. Section 5.7 of Volume 1 discusses other generalized measures DOE could use.

5.20.1 Pollution Prevention

DOE is committed to comply with Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements; Executive Order 12873, Federal Acquisition, Recycling and Waste Prevention; and applicable DOE Orders and guidance documents in planning and implementing pollution prevention at the INEL. The DOE views source reduction as the first priority in its pollution prevention program, followed by an increased emphasis on recycling. Waste treatment and disposal are considered only when prevention or recycling is not possible or practical.

5.20.2 Cultural Resources

The lack of detailed specifications associated with the proposed construction at the INEL under various alternatives precludes identifying specific project impacts and potential mitigation measures for particular structures and facilities. Basic compliance under cultural resource law involves five steps that would be essentially the same under all alternatives. These steps are (a) identification and evaluation of resources in danger of impact, (b) assessment of effects to these resources in consultation with the State Historic Preservation Office and representatives of the Shoshone-Bannock Tribes, (c) development of plans and documents to minimize any adverse effects, (d) consultation with the Advisory Council on Historic Preservation and tribal representatives as to the appropriateness of mitigation measures, and (e) implementation of potential mitigation measures. Therefore, if a cultural resource survey has not been performed in an area planned for ground disturbance under one of the proposed alternatives, consultation would be initiated with the Idaho State Historic Preservation Office and the survey would be conducted prior to any disturbance. If cultural resources were discovered, they would be evaluated according to National Register criteria. Wherever possible, important resources would be left undisturbed. If the impacts are determined to be adverse and it is not feasible to leave the resource undisturbed, then measures would be initiated to reduce impacts. All mitigation

plans would be developed in consultation with the State Historic Preservation Office and the Advisory Council on Historic Preservation and would conform to appropriate standards and guidelines established for historic preservation activities by the Secretary of the Interior.

Some actions may affect areas of religious, cultural, or historic value to Native Americans. DOE has implemented a Working Agreement (DOE 1992d) to ensure communication with the Shoshone-Bannock Tribe, especially relating to the treatment of archeological sites during excavation, as mandated by the Archeological Resources Protection Act (ARPA 1979); the protection of human remains, as required under the Native American Graves Protection and Repatriation Act (NAGPRA 1990); and the free exercise of religion as protected by the American Indian Religious Freedom Act (AIRFA 1978). In keeping with DOE Native American policy (DOE 1990), DOE Order 1230.2 (DOE 1992c), and procedures to be defined in the final Cultural Resources Management Plan for the INEL, DOE would conduct Native American consultation during the planning and implementation of all proposed alternatives. Procedures for dealing with the inadvertent discovery of human remains would be consistent with the Native American Graves Protection and Repatriation Act (NAGPRA 1990). If human remains are discovered, DOE will notify all tribes that have expressed an interest in the repatriation of graves as required under NAGPRA, including the Shoshone-Bannock, Shoshone, Painte, and the Northwestern band of the Shoshone Nation. These tribes will then have an opportunity to claim the remains and associated artifacts in accordance with the requirements of NAGPRA. Procedures for the repatriation of "cultural items" in accordance with NAGPRA will be described in a curation agreement that will be finalized by June 1996.

In addition to consultation, other measures would mitigate potential adverse effects to Native American Resources, in particular effects to air, water, plants, animals, and visual setting. These measures include avoidance of sensitive areas, placement of facilities within existing areas of construction, revegetation with native plants of areas with ground disturbance, monitoring of plants and animals within hunting and gathering areas for radiological contamination, reducing noise and night lights outside of existing facilities, monitoring tanks, ponds and runoff for contaminants, minimizing ground disturbance, use of dust suppressers during construction, and use of filters and other air pollutant control equipment to reduce air contaminants.

5.20.3 Traffic and Transportation

All onsite shipments of spent nuclear fuel would be in compliance with ID Directive 5480.3, "Hazardous Materials Packaging and Transportation Safety Requirements." These requirements provide assurance that, under normal conditions, the INEL would meet as-low-as-reasonably-achievable conditions, reasonably foreseeable accident situations (those with probability of occurrence greater than 1×10^{-7} per year) would not result in a loss of shielding or containment or a criticality, and an unintentional release of radioactive material would result in a timely response.

DOE would approve the type packages used for onsite shipments or would obtain a Nuclear Regulatory Commission or DOE certificate of compliance. If the onsite package did not have Nuclear Regulatory Commission or DOE certification, the user of the package would have to establish how administrative controls or other potential mitigating measures would ensure that the package would maintain containment and shielding integrity. The administrative and emergency response considerations would provide sufficient control so that accidents would not result in loss of containment or shielding, in criticality, or in an uncontrolled release of radioactive material that would create a hazard to the health and safety of the public or workers. Accident mitigation is described below.

5.20.4 Accidents

The DOE would initiate INEL emergency response programs, as appropriate, following the occurrence of an accident to prevent or mitigate consequences. These emergency response programs, implemented in accordance with 5500-DOE series Orders, typically involve emergency planning, emergency preparedness, and emergency response actions. Participating government agencies with plans that are interrelated with the INEL Emergency Plan for Action include the State of Idaho, Bingham County, Bonneville County, Butte County, Clark County, Jefferson County, the Bureau of Indian Affairs, and Fort Hall Indian Reservation. When an emergency condition exists at a facility, the Emergency Action Director is responsible for recognition, classification, notification, and protective action recommendations. Each emergency response plan utilizes resources specifically dedicated to assist a facility in emergency management. These resources include but are not limited to the following:

- INEL Warning Communications Center
- INEL Fire Department
- Facility Emergency Command Centers
- DOE Emergency Operations Centers
- County and State Emergency Command Centers
- Medical, health physics, and industrial hygiene specialists

- Protective clothing and equipment (respirators, breathing air supplies, etc.)
- Periodic training exercises and drills within and between the organizations involved in implementing the response plans

6. REFERENCES

Chapter 2, Background

DOE (U.S. Department of Energy), 1993, *Spent Nuclear Fuel Working Group Report on Inventory and Storage of the Departments Spent Nuclear Fuel and Other Reactor Irradiated Nuclear Materials and Their Environmental, Safety, and Health Vulnerabilities,* Volumes I, II, and III, U.S. Department of Energy, Washington, D.C., November.

DOE (U.S. Department of Energy), 1994a, *Plan of Action to Resolve Spent Nuclear Fuel Vulnerabilities, Phase I, Volumes I and II,* U.S. Department of Energy, Washington, D.C., February.

DOE (U.S. Department of Energy), 1994b, *Plan of Action to Resolve Spent Nuclear Fuel Vulnerabilities, Phase II,* U.S. Department of Energy, Washington, D.C., April.

DOE (U.S. Department of Energy), 1994c, *Plan of Action to Resolve Spent Nuclear Fuel Vulnerabilities, Phase III,* U.S. Department of Energy, Washington, D.C., October.

Chapter 3, Alternatives

DOE (U.S. Department of Energy), 1993a, Agreement between DOE and State of Idaho, August 9, 1993, as integrated into order by U.S. District Court for District of Idaho on September 21.

DOE (U.S. Department of Energy), 1993b, *Spent Nuclear Fuel Working Group Report on Inventory and Storage of the Departments Spent Nuclear Fuel and Other Reactor Irradiated Nuclear Materials and Their Environmental, Safety, and Health Vulnerabilities,* Volumes I, II, and III, U.S. Department of Energy, Washington, D.C., November.

Wichmann, T. L., 1995, U.S. Department of Energy, Idaho Operations Office, letter to Distribution, regarding "Spent Nuclear Fuel Inventory Data," OPE-EIS-95.028, February 1.

Chapter 4, Affected Environment

Abbott, M. L., J. M. Brooks, and K. L. Martin, 1990, *NPR Environmental Impacts at the INEL: Air Quality, Cooling Tower, and Noise,* NPRD-90-059, EG&G Idaho, Inc., Idaho Falls, Idaho, November.

AIRFA (American Indian Religious Freedom Act), 1978, 42 U.S.C., 1966, Public Law 95-341.

Anders, M. H., and N. H. Sleep, 1992, "Magmatism and Extension: Thermal and Mechanical Effects of the Yellowstone Hotspot," *Journal of Geophysical Research, 97,* pp. 15379-15393.

Anders, M. H., J. W. Geissman, L. A. Piety, J. T. Sullivan, 1989, "Parabolic Distribution of Circumeastern Snake River Plain Seismicity and Latest Quaternary Faulting: Migratory Pattern and Association with the Yellowstone Hotspot," *Journal of Geophysical Research, 94,* B2, pp. 1589-1621.

Anderson, J. E., 1991, *Final Report: Vegetation Studies to Support the NPR Environmental Impact Statement,* Subcontract No. C34-110421, Task Order No. 72, EG&G Idaho, Inc., Idaho Falls, Idaho.

Anderson, J. E., K. Rupple, J. Glennon, K. Holte, and R. Rope, 1995, *Vegetation, Flora, and Ethnoecology of the Idaho National Engineering Laboratory*, in press, ESRF-005, Lockheed Idaho Technologies Company, Idaho Falls, Idaho.

ARPA (Archaeological Resources Protection Act), 1979, 16 U.S.C., 470aa-470mm, Public Law 96-95; Public Law 100-555, 100-588, 1988.

Arthur, W. J., J. W. Connelly, D. K. Halford, and T. D. Reynolds, 1984, *Vertebrates of the Idaho National Engineering Laboratory,* DOE/ID-12099, U.S. Department of Energy, Idaho Falls, Idaho, July.

Arthur, W. J., O. D. Markham, C. R. Groves, B. L. Keller, and D. K. Halford, 1986, "Radiation Dose to Small Mammals Inhabiting a Solid Radioactive Waste Disposal Area," *Journal of Applied Ecology, 23,* pp. 13-26.

Bargelt, R. J., C. A. Dicke, J. M. Hubbell, M. Paarmann, D. Ryan, R. W. Smith, and T. R. Wood, 1992, *Summary of RWMC Investigations Report*, EGG-WM-9708, EG&G Idaho, Inc., Idaho National Engineering Laboratory, Idaho Falls, Idaho.

Barraclough, J. T., B. D. Lewis, and R. G. Jensen, 1981, *Hydrologic Conditions at the Idaho National Engineering Laboratory, Idaho--Emphasis: 1974-1978,* Water Resources Investigations, Open-File Report 81-526, IDO-22060, U.S. Department of Energy, Idaho Falls, Idaho, April.

Bennett, C. M., 1990, *Streamflow Losses and Ground-Water Level Changes Along the Big Lost River at the Idaho National Engineering Laboratory, Idaho,* Water-Resources Investigation Report 90-4067, DOE/ID-22091, U.S. Department of Energy, Idaho Falls, Idaho, April.

Bingham County, 1986, *1986 Bingham County Zoning Ordinance and Planning Handbook,* Bingham County Planning Commission, Blackfoot, Idaho.

Bingham County, circa 1992, "General Purpose Financial Statements for Bingham County, Idaho, for Year Ended September 30, 1991," Blackfoot, Idaho.

BLM (Bureau of Land Management), 1984, *Medicine Lodge Resource Management Plan Environmental Impact Statement,* U.S. Department of Interior, Bureau of Land Management, Idaho Falls District, Idaho Falls, Idaho.

BLM (Bureau of Land Management), 1986, *Final Environmental Impact Statement Eastern Idaho Wilderness Study,* U.S. Department of Interior, Bureau of Land Management, Idaho Falls District, Idaho Falls, Idaho.

Bonneville County, 1976, *Bonneville County Comprehensive Plan,* Bonneville County Planning Commission, Idaho Falls, Idaho, November.

Bowman, A. L., 1995, *Seismic and Volcanic Hazard Maps,* Engineering Design File SNF-EIS-0001-95 Revision 2, Lockheed Idaho Technologies Company, Idaho Falls, Idaho, February.

Braun, J. B., S. J. Miller, and B. L. Ringe, 1993, *Historically Significant Scientific and Technical Facilities at the INEL,* EGG-CS-10699, EG&G Idaho, Inc., Idaho Falls, Idaho, March.

Brott, C. A., D. D. Blackwell, and J. P. Ziagos, 1981, "Thermal Implications of the Heat Flow in the Eastern Snake River Plain, Idaho," *Journal of Geophysical Research, 86,* pp. 11709-11734.

Butte County, 1992, *Butte County Comprehensive Plan,* Butte County Planning Resource Board, Arco, Idaho.

CAA (Clean Air Act), 1990, 42 U.S.C. 7401 et seq., as amended PL 101-549, November 15.

CFR (Code of Federal Regulations), 1990, 40 CFR 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," Office of the Federal Register, Washington, D.C., November.

CFR (Code of Federal Regulations), 1991a, 40 CFR 257 and 258, "Solid Waste Disposal Facility Criteria: Final Report," Office of the Federal Register, Washington, D.C., October.

CFR (Code of Federal Regulations), 1991b, 40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards," Office of the Federal Register, Washington, D.C., revised July 1.

CFR (Code of Federal Regulations), 1991c, 40 CFR 141, "National Primary Drinking Water Regulations," Office of the Federal Register, Washington, D.C., revised July 1.

CFR (Code of Federal Regulations), 1992a, 40 CFR 61, "Protection of the Environment: National Emission Standards for Hazardous Air Pollutants," Office of the Federal Register, Washington, D.C., Revised July 1.

CFR (Code of Federal Regulations), 1992b, 40 CFR 81.313, "Protection of the Environment: Designation of Areas for Air Quality Planning Purposes - Idaho," Office of the Federal Register, Washington, D.C., Revised July 1.

Chowlewa, A. F., and D. M. Henderson, 1984, *A Survey and Assessment of the Rare Vascular Plants of the INEL,* DOE/ID-12100, U.S. Department of Energy, Idaho Operations Office, Radiological and Environmental Sciences Laboratory, Idaho Falls, Idaho.

City of Idaho Falls, 1989, *Zoning Ordinance of the City of Idaho Falls,* Ordinance No. 1941, Idaho Falls, Idaho, May.

City of Idaho Falls, 1992, *Comprehensive Plan, City of Idaho Falls, for the Year 2000,* Division of Planning and Building, Idaho Falls, Idaho.

Clark County, 1994, *Clark County Planning and Zoning Ordinance and Interim Land Use Plan,* Clark County Commissioners, Dubois, Idaho.

Clawson, K. L., G. E. Start, N. R. Ricks, 1989, *Climatography of the Idaho National Engineering Laboratory, 2nd Edition*, DOE/ID-12118, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Air Resources Laboratory, Field Research Division, Idaho Falls, Idaho, December.

COE (U.S. Corps of Engineers), 1987, *Corps of Engineers Wetland Delineation Manual,* Technical Report 4-87-1, Waterways Experiment Station, Vicksburg, Mississippi, January.

Craig, T. H., D. K. Halford, and O. D. Markham, 1979, "Radionuclide Concentrations in Nestling Raptors near Nuclear Facilities," *Wilson Bulletin, 91,* pp. 71-77.

Dames & Moore, 1992, *Revised Draft Flood Evaluation Study, Radioactive Waste Management Complex*, Dames & Moore, Idaho Falls, Idaho, July.

DOE (U.S. Department of Energy), 1990a, Memorandum EH-231: "Management of Cultural Resources at Department of Energy Facilities," U.S. Department of Energy, Washington, D.C., February 23.

DOE (U.S. Department of Energy), 1990b, Order 5400.5, "Radiation Protection of the Public and the Environment," U.S. Department of Energy, Washington, D.C., June 5.

DOE (U.S. Department of Energy), 1991a, *Draft Environmental Impact Statement for the Siting, Construction, and Operation of New Production Reactor Capacity*, Volume 4, DOE/EIS-044D, U.S. Department Of Energy, Office of New Production Reactors, Washington, D.C., April.

DOE (U.S. Department of Energy), 1991b, "Integrated Risk Information System (IRIS) and Availability of Chemical Risk Assessment Guidance," Table 1 "IRIS Chemicals With Reference Doses and Carcinogen Assessments," June, as presented in ORNL/M-3271 "Environmental Regulatory Update Table," March 1994.

DOE (U.S. Department of Energy), 1992a, Order 1230.2, "American Indian Tribal Government Policy," U.S. Department of Energy, Washington, D.C., April 8.

DOE (U.S. Department of Energy), 1992b, Order 5480.11, "Radiation Protection for Occupational Workers," U.S. Department of Energy, Washington, D.C., June 17.

DOE (U.S. Department of Energy), 1992c, "Working Agreement between the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation and the Idaho Field Office of the U.S. Department of Energy concerning Environment, Safety, Health, Cultural Resources, and Economic Self-Sufficiency," U.S. Department of Energy, Idaho Falls, Idaho, September 29.

DOE (U.S. Department of Energy), 1993a, "Memorandum of Agreement among the U.S. DOE-Idaho Field Office, the Idaho State Historic Preservation Office, and the Advisory Council on Historic Preservation" (for Auxiliary Reactor Areas I, II, and III), U.S. Department of Energy, Washington, D.C., July 15.

DOE (U.S. Department of Energy), 1993b, "Memorandum of Agreement among the U.S. DOE-Idaho Field Office, the Idaho State Historic Preservation Office, and the Advisory Council on Historic Preservation" (for Test Area North 629 Hangar), U.S. Department of Energy, Washington, D.C., November 18.

DOE (U.S. Department of Energy), 1994, *Evaluation Guidelines for Accident Analysis and Safety Structures, Systems, and Components*, Proposed Standard DOE-DP-STD-3005-YR, Draft, U.S. Department of Energy, Washington, D.C., February 25.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 1991, *Personnel Survey Results*, Idaho National Engineering Laboratory (available from U.S. Department of Energy), Idaho Falls, Idaho, July.

DOE-ID (U.S. Department of Energy Idaho Operations Office), 1993a, *INEL Technical Site Information Report*, DOE-/ID-10401, U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho.

DOE-ID (U.S. Department of Energy Idaho Operations Office), 1993b, *Idaho National Engineering Laboratory Storm Water Pollution Prevention Plan for Industrial Activities*, DOE/ID-10431, Revision 1, U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho, September 15.

DOE-ID (U.S. Department of Energy Idaho Operations Office), 1993c, *Institutional Plan for Fiscal Years 1994-1999 (Draft)*, U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho, June.

DOE-ID (U.S. Department of Energy Idaho Operations Office), 1993d, *INEL Nonradiological Waste Management Information System (NWIMS)*, DOE/ID-10057(1992), U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho, April.

DOE-ID (U.S. Department of Energy Idaho Operations Office), 1993e, *INEL Nonradiological Waste Management Information System (NWIMS)*, DOE/ID-10057(1992), U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho, August.

DOE-ID (U.S. Department of Energy Idaho Operations Office), 1994, *INEL Historical Headcount and INEL Projected Headcount*, U.S. Department of Energy, Idaho Operations Office, March.

Doherty, D. J., 1979a, *Drilling Data from Exploration Well 1, NE 1/4, sec. 22, T.2N., R. 32E., Bingham County, Idaho*, Open-File Report 79-1225, U.S. Geological Survey, Idaho Falls, Idaho, 1 sheet.

Doherty, D. J., 1979b, *Drilling Data from Exploration Well 2-2A, NW 1/4, sec. 15, T.5N., R.31E., Idaho National Engineering Laboratory, Butte County, Idaho*, Open-File Report 79-851, U.S. Geological Survey, Idaho Falls, Idaho, 1 sheet.

Doherty, D. J., L. A. Morgan, and M. A. Kuntz, 1979, *Preliminary Geologic Interpretation and Lithologic Log of the Exploratory Geothermal Test Well (INEL-1), Idaho National Engineering Laboratory, Eastern Snake River Plain, Idaho*, Open-File Report 79-1248, U.S. Geological Survey, Idaho Falls, Idaho, 1 sheet.

Draney, Searle & Associates, 1992, *Jefferson Country General Purpose Financial Statements Ended September 30, 1991*, Draney, Searle, & Associates, Idaho Falls, Idaho, March.

Driscoll, F. G., 1989, *Groundwater and Wells*, second edition, St. Paul, Minnesota: Johnson Filtration Systems, Inc., p. 61.

Edwards, D. D., R. C. Bartholomay, and C. M. Bennett, 1990, *Nutrients, Pesticides, Surfactants, and Trace Metals in Groundwater from the Howe and Mud Areas Upgradient from the Idaho National Engineering Laboratory, Idaho*, Open-File Report 90-565, DOE/ID-22093, U.S. Department of Energy, Idaho Falls, Idaho.

EG&G (EG&G Idaho, Inc.), 1984, *INEL Environmental Characterization Report*, EGG-NPR-6688, EG&G Idaho, Inc., Idaho Falls, Idaho, September.

EG&G (EG&G Idaho, Inc.), 1993, *Environmental Restoration and Waste Management Engineering Design File - Projected INEL Waste Inventories*, ER&WM-EDF-0015-93, Revision 6A, EG&G Idaho, Inc., Idaho Falls, Idaho, November 24.

EPA (U.S. Environmental Protection Agency), 1974, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, EPA-550/9-74-004 (PB-239429), U.S. Environmental Protection Agency, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1989, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D.C., December.

EPA (U.S. Environmental Protection Agency), 1993a, "Drinking Water Regulations and Health Advisories," U.S. Environmental Protection Agency, Washington, D.C., December.

EPA (U.S. Environmental Protection Agency), 1993b, *Guidelines of Air Quality Models* (revised), EPA-450/2-78-027R, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, July.

Evenson, L. M., 1981, *Systemic Effects of Radiation Exposure on Rodents Inhabiting Liquid and Solid Radioactive Waste Disposal Areas,* master's thesis, University of Idaho, Moscow, Idaho, April.

FR (Federal Register), 1991a, "National Primary Drinking Water Regulations; Radionuclides," Notice of Proposed Rulemaking, 56 FR 138, U.S. Environmental Protection Agency, Washington, D.C., July 18, pp. 33050-33127.

FR (Federal Register), 1991b, "Sole Source Designation of the Eastern Snake River Plain Aquifer, Southern Idaho: Final Determination," 56 FR 194, U.S. Environmental Protection Agency, Washington, D.C., October 7, pp. 50634-50638.

Gaia Northwest, Inc., 1988, *Drinking Water Consumption and Alternative Sources for the Eastern Snake River Plain, Idaho*, Gaia Northwest Inc., Seattle, Washington, November.

Garabedian, S. P., 1986, *Application of a Parameter Estimation Technique to Modeling the Regional Aquifer Underlying the Eastern Snake River Plain, Idaho,* Water-Supply Paper 2278, U.S. Geological Survey, Alexandria, Virginia.

Garabedian, S. P., 1989, *Hydrology and Digital Simulation of the Regional Aquifer System, Eastern Snake River Plain, Idaho,* Open-File Report 87-237, U.S. Geological Survey, Alexandria, Virginia.

Ghan, L. W., 1992, Bannock County, *Idaho Comprehensive Annual Financial Report for the Fiscal Year Ended September 20, 1991,* Pocatello, Idaho, January 15.

Gilbert, H. K., and B. L. Ringe, 1993, *Inventory of Known Historical Cultural Resources on the INEL and Preliminary Analysis of Historic Sensitivity,* EGG-CS-10707, EG&G Idaho, Inc., Idaho Falls, Idaho, March.

Golder Associates. 1994. *Assessment of Trends in Groundwater Quality at the Idaho National Engineering Laboratory*. Report No. 933-1151. Golder Associates, Inc., Idaho Falls, Idaho. September 7.

Hackett, W.R., and L. A. Morgan, 1988, "Explosive Basaltic and Rhyolitic Volcanism of the Eastern Snake River Plain," in *Guidebook to the Geology of Central and Southern Idaho*, P. K. Link, and W. R. Hackett, editors, *Idaho Geological Survey Bulletin*, 27, pp. 283-301.

Hackett, W. R., and R. P. Smith, 1992, "Quaternary Volcanism, Tectonics, and Sedimentation in the Idaho National Engineering Laboratory Area," in *Field Guide to Geologic Excursions in Utah and Adjacent Areas of Nevada, Idaho, and Wyoming*, J. R. Wilson, editor, *Geological Society of America Rocky Mountain Section Guidebook*, Utah Geological Survey Miscellaneous Publication 92-3, pp. 1-18.

Halford, D. K., and O. D. Markham, 1978, "Radiation Dosimetry of Small Mammals Inhabiting a Liquid Radioactive Waste Disposal Area," *Ecology, 59* p. 1047-1054.

Hampton, N. L., R. C. Rope, J. M. Glennon, K. S. Moor, 1993, *A Preliminary Survey of Designated Wetlands on the Idaho National Engineering Laboratory*, EGG-EEL-10629, EG&G Idaho, Idaho Falls, Idaho, March.

Hardinger, D., 1990, *Socioeconomic Database for Southeastern Idaho*, EG&G Idaho, Inc., Idaho Falls, Idaho, April.

Hoff, D. L., R. G. Mitchell, G. C. Bowman, and R. Moore, 1990, *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1989*, DOE/ID-12082(89), U.S. Department of Energy, Radiological and Environmental Sciences Laboratory, Idaho Falls, Idaho, June.

IDE (Idaho Department of Education), 1991, *Public and Non-Public School Certified Personnel and Employees in Noncertified Positions 1990-1991*. Idaho Department of Education, Finance Division, Boise, Idaho, March.

IDHW (Idaho Department of Health and Welfare), 1990, *1990 Hospital Utilization Report*, Idaho Department of Health and Welfare, Office of Health Policy and Rescue, Boise, Idaho.

IDHW (Idaho Department of Health and Welfare), 1994, *Rules for the Control of Air Pollution in Idaho*, Idaho Department of Health and Welfare, Division of Environmental Quality, Boise, Idaho.

IDLE (Idaho Department of Law Enforcement), 1991, *Crime in Idaho*, Idaho Department of Law Enforcement, Bureau of Criminal Identification, Boise, Idaho.

IDWR (Idaho Department of Water Resources), 1980, *Geothermal Investigations in Idaho, Part 9, Potential for Direct Heat Application of Geothermal Resources*, IDWR Water Information Bulletin No. 30, Idaho Department of Water Resources, Boise, Idaho.

IPC/DOE (Idaho Power Company/U.S. Department of Energy), 1986, "Contract for Electric Service between Idaho Power Company and United States Department of Energy Idaho Operations Office," Contract No. DE-AC07-86ID12588, effective date November 1, 1986.

Irving, J. S., 1993, *Environmental Resource Document for the Idaho National Engineering Laboratory*, EGG-WM0-10279, EG&G Idaho, Inc., Idaho Falls, Idaho, July.

ISDE (Idaho State Department of Employment), 1986, *Idaho Employment*, Idaho State Department of Employment, Research and Analysis Bureau, Boise, Idaho, February.

ISDE (Idaho State Department of Employment), 1991, *Idaho Employment*, Idaho State Department of Employment, Research and Analysis Bureau, Boise, Idaho, February.

ISDE (Idaho State Department of Employment), 1992, Idaho State Department of Employment, Research and Analysis Bureau, Boise, Idaho, February.

Jackson, S. M., 1985, "Acceleration data from 1983 Borah Peak, Idaho earthquake recorded at the Idaho National Engineering Laboratory," in *Processing of Workshop XXVIII On the Borah Peak, Idaho, Earthquake*, R. S. Stein and R. C. Buckham, editors, U.S. Geological Survey Open-File Report 85-290, U.S. Geological Survey, Idaho Falls, Idaho, pp. 385-400.

Jackson, S. M., I. G. Wong, G. S. Carpenter, D. M. Anderson, and S. M. Martin, 1993, "Contemporary Seismicity in the Eastern Snake River Plain, Idaho, Based on Microearthquake Monitoring," *Bulletin of the Seismological Society of America, 83*, pp. 680-695.

Jefferson County, 1988, *Jefferson County Idaho Comprehensive Plan*, Jefferson County Planning Commission, Rigby, Idaho, May.

King, J. J., T. E. Doyle, and S. M. Jackson, 1987, "Seismicity of the Eastern Snake River Plain Region, Idaho, Prior to the Borah Peak, Idaho Earthquake: October 1972 - October 1983," *Bulletin of the Seismological Society of America, 77*, 3, pp. 809-818.

Koslow, K. N., 1984, *Hydrological Characterization of Birch Creek Basin*, EGG-PBS-6782, EG&G Idaho, Inc., Idaho Falls, Idaho.

Koslow, K. N., and D. H. Van Haaften, 1986, *Flood Routing Analysis for a Failure of Mackay Dam*, EGG-EP-7184, EG&G Idaho, Inc., Idaho Falls, Idaho, June.

Kouris, C., 1992a, Ecology and Environment, Idaho Falls, Idaho, records of personal communications provided to I. Johnson, Science Applications International Corporation, Portland, Oregon, regarding fire protection statistics.

Kouris, C., 1992b, Ecology and Environment, Idaho Falls, Idaho, records of personal communications provided to I. Johnson, Science Applications International Corporation, Portland, Oregon, regarding municipal solid waste disposal.

Kramber, W. L., R. C. Rope, J. Anderson, J. Giennon, and A. Morse, 1992, "Producing a Vegetation Map of the Idaho National Engineering Laboratory using Landsat Thematic Mapper Data," in *Proceedings of the ASPRS 1992 Annual Meeting, Albuquerque, New Mexico, March, 1992*.

Kuntz, M. A., B. Skipp, M. A. Lanphere, W. E. Scott, K. L. Pierce, G. Dalrymple, L. A. Morgan, D. E. Champion, G. R. Embree, R. P. Smith, W. R. Hackett, and D. W. Rodgers, compiled by W. R. Page, 1990, *Revised Geologic Map of the INEL and Adjoining Areas, Eastern Idaho*, Open-File Report, 990-333, U.S. Geological Survey, Idaho Falls, Idaho, scale 1:100,000.

Kuntz, M. A., H. R. Covington, and L. J. Schorr, 1992, "An Overview of Basaltic Volcanism of the Eastern Snake River Plain, Idaho," in *Regional Geology of Eastern Idaho and Western Wyoming*, P. K. Link, M. A. Kuntz, and L. B. Platt, editors, Memoir 179, Geological Society of America, Denver, Colorado, pp. 227-267.

Leenheer, J. A., and J. C. Bagby, 1982, *Organic Solutes in Groundwater at the Idaho Engineering Laboratory*, Open-File Report 82-15, IDO-22061, U.S. Department of Energy, Idaho Falls, Idaho, March.

Lehto, W. K., 1993, *Traffic and Transportation*, Revision 1, Engineering Design File ER&WM-EDF-0020-93, EG&G Idaho, Inc., Idaho Falls, Idaho, December.

Liszewski, M. J., and L. J. Mann, 1992, *Purgeable Organic Compounds in Groundwater at the Idaho National Engineering Laboratory, Idaho--1990 and 1991*, Open-File Report 92-174, DOE/ID-22104, U.S. Department of Energy, Idaho Falls, Idaho, July.

Lobdell, C., 1992, U.S. Department of Interior, Fish and Wildlife Service, Boise Field Office, Boise, Idaho, letter to R. Rothman, U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho, providing a list of endangered, threatened, proposed, and candidate species that may be present within the area of the proposed action sent in response to Notice of Intent, FWS-1-4-93-SP-84, December 15.

Lobdell, C., 1995, U.S. Department of Interior, Fish and Wildlife Service, Boise Field Office, Boise Idaho, letter to T. Reynolds, Environmental Science Research Foundation, Idaho Falls, Idaho, providing an updated list of endangered, proposed, and candidate species at the Idaho National Engineering Laboratory, FWS-1-4-95, January 24.

Maheras, S. J., 1993, *Health Effects from Onsite INEL Baseline Incident-Free Transportation*, Engineering Design File EIS-TRANS-07, Science Applications International Corporation, Idaho Falls, Idaho, December.

Mann, L. J., 1990, *Purgeable Organic Compounds in Groundwater at the Idaho National Engineering Laboratory, Idaho*, Open-File Report 90-387, DOE/ID-22089, U.S. Department of Energy, Idaho Falls, Idaho, July.

Mann, L. J., 1994, U.S. Geological Survey, INEL Field Office, Idaho Falls, Idaho, records of personal communications provided to A. L. Lundahl, Science Applications International Corporation, Idaho Falls, Idaho, January 17.

Mann, L. J., and L. L. Knobel, 1987, *Purgeable Organic Compounds in Groundwater at the Idaho National Engineering Laboratory, Idaho,* Open-File Report 87-766, DOE/ID-22074, U.S. Department of Energy, Idaho Falls, Idaho, December.

Mann, L. J., E. W. Chew, and J. S. Morton, 1988, *Iodine-129 in the Snake River Plain Aquifer at the Idaho National Engineering Laboratory, Idaho,* Open-File Report 88-4165, DOE/ID-22076, U.S. Department of Energy, Idaho Falls, Idaho, September.

Mann, L. J., and L. D. Cecil, 1990, *Tritium in Groundwater at the Idaho National Engineering Laboratory, Idaho,* Open-File Report 90-4090, DOE/ID-22090, U.S. Department of Energy, Idaho Falls, Idaho, June.

Markham, O. D., 1974, "Environmental and Radiological Monitoring at the National Reactor Testing Station during FY-1973 (July 1972-June 1973)," *Radiation and Data Reports, 15*, pp. 227-246, May.

Markham, O. D., R. E. Authenrieth, and R. L. Dickson, 1982, "Radionuclides in Pronghorn Resulting from Nuclear Fuel Reprocessing and Worldwide Fallout," *Journal of Wildlife Management, 46*, pp. 30-42.

McFadden, J., circa 1992, *1991 Annual Financial Report of Bonneville County at the Close of Business September 30, 1992,* Idaho Falls, Idaho.

Mitchell, V. E., W. B. Strowd, G. S. Hustedde, and E. H. Bennett, 1981, *Mines and Prospects of the Dubois Quadrangle, Idaho*, Mines and Prospects Map Series, Idaho Bureau of Mines and Geology, Moscow, Idaho, December.

Millard, J. B., F. W. Whicker, and O. D. Markham, 1990, "Radionuclide Uptake and Growth of Barn Swallows Nesting by Radioactive Leaching Ponds," *Health Physics, 58*, pp. 429-439.

Miller, S. J., 1992, *Idaho National Engineering Laboratory Management Plan for Cultural Resources (Draft)*, DOE/ID-10361, U.S. Department of Energy, Idaho Falls, Idaho, March.

Morris, R. C., 1993, "The Implications of Lined Radioactive Waste Ponds for Waterfowl Contamination," in *Environmental Health Physics, Proceedings of the Twenty-Sixth Midyear Topical Meeting of the Health Physics Society, Coeur dAlene, January 24-28, 1993,* R. L. Kathren, D. H. Denham, K. Salmon, eds., Richland, Washington: Columbia Chapter, Health Physics Society, pp. 147-155.

Morton, D. E., and K. D. Hendrickson, 1995, "TRU, LLW, MLLW, GTCC, HazW, & IndW Generation, Storage, & Treatment Volumes," Engineering Design File EDF-94-WASTE-104, Science Applications International Corporation, Idaho Falls, Idaho, January 1995.

NAGPRA (Native American Graves Protection and Repatriation Act), 1990, 25 U.S.C. 3001, Public Law 101-601.

NEPA (National Environmental Policy Act), 1969, 42 U.S.C. 4321-4361, Public Law 91-190, 1976; 40 CFR 1500-1508; 10 CFR 1021; EO 11514, 11991.

NHPA (National Historic Preservation Act), 1966, 16 U.S.C. 470; Public Law 89-665, 36 CFR 60-68.800; 48 FR 44716-44742; Public Law 102-575.

Notar, J., 1993, U.S. National Park Service, Denver Regional Office, records of personal communications provided to D. A. Ryan, Science Applications International Corporation, Idaho Falls, Idaho, November 22.

Orr, B. R., and L. D. Cecil, 1991, *Hydrologic Conditions and Distribution of Selected Chemical Constituents in Water, Snake River Plain Aquifer, Idaho National Engineering Laboratory, Idaho, 1986 to 1988,* Open-File Report 91-4047, DOE/ID-22096, U.S. Department of Energy, Idaho Falls, Idaho, February.

Orr, B. R., L. D. Cecil, and L. L. Knobel, 1991, *Background Concentrations of Selected Radionuclides, Organic Compounds, and Chemical Constituents in Groundwater in the Vicinity of the Idaho National Engineering Laboratory*, Open-File Report 91-4015, DOE/ID-22094, U.S. Department of Energy, Idaho Falls, Idaho, March.

Parsons, T., and G. Thompson, 1991, "The Role of Magma Overpressure in Suppressing Earthquakes and Topography: Worldwide Examples, *Science*, 253, pp. 1399-1402.

Pelton, J. R., R. J. Vincent, and N. J. Anderson, 1990, "Microearthquakes in the Middle Butte/East Butte Area, Eastern Snake River Plain, Idaho," *Bulletin of the Seismological Society of America, 80*, no. 1, pp. 209-212.

Pierce, K. L., and L. A. Morgan, 1992, "The track of the Yellowstone hotspot: Volcanism, Faulting, and Uplift," in *Regional Geology of Eastern Idaho and Western Wyoming*, P. K. Link, M. A. Kuntz, and L. B. Platt, editors, Memoir 179, Geological Society of America, Denver, Colorado, pp. 1-53.

Pittman, J. R., R. G. Jensen, and P. R. Fischer, 1988, *Hydrologic Conditions at the Idaho National Engineering Laboratory, 1982 to 1985*, Water-Resources Investigation Report 89-4008, DOE/ID-22078, U.S. Department of Energy, Idaho Falls, Idaho, Idaho, December.

Reynolds, T. D., J. W. Connelly, D. K. Halford, and W. J. Arthur, 1986, "Vertebrate Fauna of the Idaho National Environmental Research Park," *Great Basin Naturalist, 46*, pp. 513-527.

Reynolds, T. D., 1993, U.S. Department of Energy, Idaho Operations Office, records of personal communications provided to T. Doerr, Science Applications International Corporation, Science Applications International Corporation, September 8.

Ringe, B. L., 1993, *Locational Analysis and Preliminary Predictive Model for Prehistoric Cultural Resources on the INEL (Draft)*, EGG-CS-10706, EG&G Idaho, Inc., Idaho Falls, Idaho, March.

Robertson, J. B., R. Schoen, and J. T. Barraclough, 1974, *The Influence of Liquid Waste Disposal on the Geochemistry of Water at the National Reactor Testing Station, Idaho:* 1952-1970, Open-File Report IDO-22053, U.S. Department of Energy, Idaho Falls, Idaho, February.

Rodgers, D. W., W. R. Hackett, and H. T. Ore, 1990, "Extension of the Yellowstone plateau, Eastern Snake River Plain, and Owyhee plateau," *Geology, 18*, pp. 1138-1142.

Rope, R. C., N. L. Hampton, K. A. Finley, 1993, "Ecological Resources," in Irving, J. S., *Environmental Resource Document for the Idaho National Engineering Laboratory*, Volumes I and II, EGG-WMD-10279, EG&G Idaho, Inc., Idaho Falls, Idaho, July.

SAIC (Science Applications International Corporation), 1994, "Forecast of Labor Force, Employment, and Population Based on Historical Data from the Idaho State Department of Employment," data sheet, Science Applications International Corporation, Idaho Falls, Idaho, March.

Schafer-Pereni, A. L., 1993, "TAN Groundwater RI/FS Contaminant Fate and Transport Modeling Results," Engineering Design File, ER-WAG1-21, EG&G Idaho, Inc., Idaho Falls, Idaho.

Schwendiman & Sutton, 1992, *Madison County, Idaho Financial Statements, Supplemental Data and Independent Auditors Reports for Year Ended September 30, 1991*, Schwendiman & Sutton, Rexburg, Idaho, January 28.

SDWA (Safe Drinking Water Act), 1974, §1427 (42 USC 300h-6) Sole Source Aquifer Demonstration Program.

Smith, R. B., and M. L. Sbar, 1974, "Contemporary Tectonics and Seismicity of the Western United States with Emphasis on the Intermountain Seismic Belt," *Geological Society of America Bulletin, 85*, pp. 1205-1218.

Smith, R. B., and W. J. Arabasz, 1991, "Seismicity of the Intermountains Seismic Belt," in *Neotectonics of North America;* D. B. Slemmons, E. R. Engdahl, M. D. Zoback, and D. D. Blackwell, editors, Decade Map Volume 1, *Geological Society of America*, Boulder, Colorado, pp. 185-221.

State of Idaho Code, 1975, *Local Planning Act of 1975 (I.C. #67-6501 et seq.)*, Boise, Idaho.

Strowd W. B., V. E. Mitchell, G. S. Hostedde, R. H. Bennett, 1981, *Mines and Prospects of the Idaho Falls Quadrangle, Idaho*, Mines and Prospects Map Series, Idaho Bureau of Mines and Geology, Boise, Idaho.

Swager & Swager, 1992a, *Butte County, Idaho Audited General Purpose Financial Statements with Report of Certified Public Accountant for Year Ended September 30, 1991*, Swager & Swager, Rigby, Idaho, December 27.

Swager & Swager, 1992b, *Clark County, Idaho General Purpose Financial Statements and Supplementary Information with Report of Certified Public Accountant Year Ended September 30, 1991*, Swager & Swager, Rigby, Idaho, December 27.

Teel, D. M., 1993, "Utilities and Energy," Engineering Design File ER&WM-EDF-0019-93, EG&G Idaho, Inc., Idaho Falls, Idaho, September 17.

Tellez, C. L., 1995, Lockhead Idaho Technologies Company, Idaho Falls, Idaho, letter to T. L. Wichmann, U.S. Department of Energy, Idaho Operations Office, subject: "Projected LITCO Employment Numbers for 1995 to 2004," CLT-4-9, January 9.

U.S. West Directories, 1992, *Easy Reference Guide, Salt Lake City, Utah*, U.S. West Direct, Aurora, Colorado.

USBC (U.S. Bureau of the Census), 1982, *1980 Census of Population and Housing*, U.S. Bureau of the Census, Washington, D.C.

USBC (U.S. Bureau of the Census), 1992, *1990 Census of Population and Housing*, U.S. Bureau of the Census, Washington, D.C.

Volcanism Working Group, 1990, *Assessment of Potential Volcanic Hazards for the New Production Reactor Site at the Idaho National Engineering Laboratory*, EGG-NPR-10624, EG&G Idaho, Inc., Idaho Falls, Idaho, October.

Weaver C. S., A. M. Pitt, and D. P. Hill, 1979, "Crustal Spreading Direction of the Snake River Plain-Yellowstone System," *EOS, 60*, p. 946.

Wilhelmson, R. N., K. C. Wright, and D. W. McBride, 1993, *Annual Report--1992 Environmental Surveillance for EG&G Idaho Waste Management Facilities at the Idaho National Engineering Laboratory, EGG-2679(92)*, EG&G Idaho, Inc., Idaho Falls, Idaho, August.

Wood, W. W., and W. H. Low, 1986, "Aqueous Geochemistry and Digenesis in the Eastern Snake River Plain Aquifer System," Idaho, *Geologic Society of America Bulletin, 97 (12)*, pp. 1456-1466.

Wood, W. W., and W. H. Low, 1988, *Solute Geochemistry of the Snake River Plain Regional Aquifer System, Idaho and Eastern Oregon*, Professional Paper 1408-D, U.S. Geological Survey, Idaho Falls, Idaho.

WCC (Woodward-Clyde Consultants), 1990, *Earthquake Strong Ground Motion Estimates for the Idaho National Engineering Laboratory: Final Report*, three volumes, EGG-BG-9350, EG&G Idaho, Inc., Idaho Falls, Idaho, November.

WCC (Woodward-Clyde Consultants), 1992, *Earthquake Strong Ground Motion Evaluations for the Proposed New Production Reactor at the Idaho National Engineering Laboratory*, two volumes, EGG-GEO-10304, EG&G Idaho, Inc., Idaho Falls, Idaho, June.

WCFS (Woodward Clyde Federal Services), 1993, *Site-Specific Probabilistic Seismic Hazard Analysis for the Idaho National Engineering Laboratory* (draft), prepared by Woodward-Clyde Federal Services for EG&G Idaho, Inc., Idaho Falls, Idaho, June.

Yohe, R., 1993, Idaho State Historical Preservation Office, Boise, Idaho, record of personal communications provided to T. Rudolph, Science Applications International Corporation, Boise, Idaho, September 10.

Zoback, M. L., and M. D. Zoback, 1989, "Tectonic stress field of the Continental United States," in *Geophysical Framework of the Continental United States*, L. C. Pakiser and W. D. Mooney, editors, Memoir 179, *Geological Society of America Memoir*, Menlo Park, California, pp. 523-539.

ACGIH (American Conference of Governmental Industrial Hygienists). 1988. *Threshold Limit Values and Biological Exposure Indices for 1989-1990*. American Conference of Governmental Industrial Hygienists. Cincinnati. Ohio. March.

AIRFA (American Indian Religious Freedom Act). 1978. 42 U.S.C.. 1966. Public Law 95-341.

ANL (Argonne National Laboratory-West). 1975. "Hot Fuel Examination Facility/North Facility Safety Report." ANL-7959. LMFBR Fuel Handling (UC-79g). Argonne-West. Idaho National Engineering Laboratory. Idaho Falls. Idaho. February.

ANL (Argonne National Laboratory-West). 1994. *Chlorine Gas Release*. Occurrence Report Number CH-AA-ANLW-ANLW-1994-004. Notification Report. Argonne National Laboratory. Idaho Falls. Idaho. April 18.

Arnett. R. C.. 1994. EG&G Idaho. Inc.. Idaho Falls. Idaho. memorandum to A. L. Bowman. EG&G Idaho. Inc.. Idaho Falls. Idaho. subject: "Calculated Contaminant Releases from Spent Nuclear Fuel Wet Transfer and Storage Systems." RCA-05-94. May 10.

ARPA (Archaeological Resources Protection Act). 1979. 16 U.S.C.. 470aa-470mm. Public Law 96-95; Public Law 100-555. 100-588. 1988.

Belanger. R. J.. J. Raudsep. and D. R. Ryan. 1995. *Technical Support Document for Air Resources. INEL Environmental Restoration and Waste Management Program*. DOE-ID-10497. Science Applications International Corporation. Idaho Falls. Idaho. March.

Bowman. A. L.. 1994. EG&G Idaho. Inc.. Idaho Falls. Idaho. memorandum to M. Wilcox. U.S. Department of Energy. Idaho Operations Office. Idaho Falls. Idaho. subject: "Aquifer Consequences Due to ICPP Tank Rupture." ALB-01-94. January 17.

Braun. J. B.. S. J. Miller. and B. L. Ringe. 1993. *Historically Significant Scientific and Technical Facilities at the INEL*. EGG-CS-10699. EG&G Idaho. Inc.. Idaho Falls. Idaho.

Cashwell. J. W.. K. S. Neuhauser. P. C. Reardon. and G. W. McNair. 1986. *Transportation Impacts of the Commercial Radioactive Waste Management Program*. SAND85-2715. Sandia National Laboratories. Albuquerque. New Mexico. December.

CFR (Code of Federal Regulations). 1991. 40 CFR 50. "National Primary and Secondary Ambient Air Quality Standards." Office of the Federal Register. Washington. D.C.. revised July 1.

CFR (Code of Federal Regulations). 1992a. 40 CFR 302. Ch. 1. "Designation. Reportable Quantities. and Notification." Office of the Federal Register. July 1.

CFR (Code of Federal Regulations). 1992b. 40 CFR 372. Ch. 1. "Toxic Chemical Release Reporting: Community Right-to-Know." Office of the Federal Register. July 1.

CFR (Code of Federal Regulations). 1992c. 40 CFR 61. "National Emission Standards for Hazardous Air Pollutants." Office of the Federal Register. Washington. D.C.. revised July 1.

CFR (Code of Federal Regulations). 1993. 40 CFR 355. Appendices A and B. Lists of Extremely Hazardous Substances and Their Threshold Planning Quantities. Office of the Federal Register.

Creed. B.. 1994. U.S. Department of Energy. Idaho Operations Office. Idaho Falls. Idaho. memorandum to distribution. subject: "Non-Zero Source Terms for Spent Nuclear Fuel (SNF) Wet Transfer and Storage and Criteria Checklist Compliance." OPE-EIS-94.169. March 30.

DOE (U.S. Department of Energy). 1987. Order 5481.1B. "Safety Analysis and Review System." U.S. Department of Energy. Washington D.C.. May 19.

DOE (U.S. Department of Energy). 1990. Memorandum EH-231: "Management of Cultural Resources at Department of Energy Facilities." U.S. Department of Energy. Washington. D.C.. February 23.

DOE (U.S. Department of Energy). 1991. "Idaho National Engineering Laboratory Historical Dose Evaluation." DOE/ID-12119. U.S. Department of Energy. Idaho Operations Office. Idaho Falls. Idaho. August.

DOE (U.S. Department of Energy), 1992a, Order 5480.23, "Nuclear Safety Analysis Reports," U.S. Department of Energy, Washington, D.C., April 30.

DOE (U.S. Department of Energy), 1992b, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23 Nuclear Safety Analysis Reports," Standard DOE-STD-1027-92, U.S. Department of Energy, Washington, D.C., December.

DOE (U.S. Department of Energy), 1992c, Order 1230.2, "American Indian Tribal Government Policy," U.S. Department of Energy, Washington, D.C., April 8.

DOE (U.S. Department of Energy), 1992d, "Working Agreement between the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation and the Idaho Falls Field Office of the U.S. Department of Energy concerning Environment, Safety, Health, Cultural Resources, and Economic Self-Sufficiency," U.S. Department of Energy, Idaho Falls, Idaho, September 29.

DOE (U.S. Department of Energy), 1993a, *Environmental Assessment Test Area North Pool Stabilization Project*, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho, June.

DOE (U.S. Department of Energy), 1993b, *Occupational Injury and Property Damage Summary*, DOE/EH/01570-H2, U.S. Department of Energy, Washington, D.C., March 1993, page 9.

DOE (U.S. Department of Energy), 1993c, *Spent Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and Other Radioactive Irradiated Nuclear Materials and Their Environmental, Safety and Health Vulnerabilities*, Volume 1, U.S. Department of Energy, Washington, D.C., November.

DOE (U.S. Department of Energy), 1994a, *Evaluation Guidelines for Accident Analysis and Safety Structures, Systems, and Components*, Proposed Standard DOE-DP-STD-3005-YR, Draft, U.S. Department of Energy, Washington, D.C., February 25.

DOE (U.S. Department of Energy), 1994b, U.S. Department of Energy Operations Office Service Center, Electronic Message, *"Alert at INEL,"* discussing April 15, 1994 accidental chlorine release, April 15, 1994, 2:05 p.m.

EG&G (EG&G Idaho, Inc.), 1993a, *Environmental Restoration and Waste Management Engineering Design File - Projected INEL Waste Inventories*, ER&WM-EDF-0015-93, Revision 6A, EG&G Idaho, Inc., Idaho Falls, Idaho, November 24.

EG&G (EG&G Idaho, Inc.), 1993b, *NPR-MHTGR, Generic Reactor Plant Description & Source Terms, Addenda I & II, Adaptations for Siting the Heavy-Water Reactor (HWR) and Light-Water Reactor (LWR) at the INEL*, EGG-NPR-8522, Volume II, Revision A, EG&G Idaho, Inc., Idaho Falls, Idaho, April.

EG&G (EG&G Idaho, Inc.), 1994, *INEL Gravel/Borrow Resource and Compliance Assessment*, EGG-FM-11261, EG&G Idaho, Inc., Idaho Falls, Idaho, May 16.

Enyeart, T., 1994, "Maximum Reasonably Foreseeable Accident for Onsite Transportation of Spent Nuclear Fuel at the Idaho National Engineering Laboratory," Engineering Design File EIS-TRANS-35, Science Applications International, Idaho Falls, Idaho, August 24.

EPA (U.S. Environmental Protection Agency), 1974, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, EPA-550/9-74-004 (PB-239429), U.S Environmental Protection Agency, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1982, *Guidelines for Noise Impact Analysis*, EPA-550/9-82-105 (PB82-219205), U.S. Environmental Protection Agency, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1990, "EPA Title III List of Lists," EPA 560/4-90-011, U.S. Environmental Protection Agency, Office of Toxic Substances and Office of Solid Waste and Emergency Response, Washington, D.C., January.

EPA/FEMA/DOT (U.S. Environmental Protection Agency, Federal Emergency Management Agency, U.S. Department of Transportation), 1987, *Technical Guidance for Hazards Analysis: Emergency Planning for Extremely Hazardous Substances*, U.S. Environmental Protection Agency, Washington, D.C., December.

FICON (Federal Interagency Committee on Noise), 1992, *Federal Agency Review of Selected Airport Noise Analysis Issues*, Federal Aviation Administration, U.S. Department of Transportation, Washington, D.C.

FR (Federal Register), 1994, 59 FR 20, Environmental Protection Agency, 40 CFR Parts 9 and 68, "List of Regulated Substances and Thresholds for Accidental Release Prevention and Risk Management," Final Notice and Rule, January 31, pp. 4478-4501.

Freund, G., 1994, *High-Level Liquid Waste and Calcine Volumes*, EDF-94-HLW-0103, Science Applications International Corporation, Idaho Falls, Idaho, July 27.

Heiselmann, H. W., 1995, *DOE Complex Wide Spent Nuclear Fuel Shipment Estimates for the DOE Programmatic Spent Nuclear Fuel Management Environmental Impact Statement*, Engineering Design Final EIS-TRANS-20, Rev. 2, Science Applications International Corporation, Idaho Falls, Idaho, March.

Hendrix, C. E., 1994, "Occupational Facility Rates for the State of Idaho," Engineering Design File, Science Applications International Corporation, Idaho Falls, Idaho, January 17.

Hendrickson, K. D., 1995, "Estimates of Utility Usage," Engineering Design File No. EIS-SERV-001, Science Applications International Corporation, Idaho Falls, Idaho, January 17.

ICRP (International Commission on Radiological Protection) 1991, Publication 60, "1990 Recommendations of the International Commission on Radiological Protection," Volume 21, No. 1-3, Pergammon Press, New York, New York.

Johnson, I., 1995, Science Applications International Corporation, Boise, Idaho, letter to K. Gunther, Halliburton NUS Corporation, Aiken, South Carolina, regarding "Revised Project Summary Data for SNF & INEL EIS Volume 1, Appendix B," February 23.

Madsen, M. M., J. M. Taylor, R. M. Ostmeyer, and P. C. Reardon, 1986, *RADTRAN III*, SAND84-0036, Sandia National Laboratories, Albuquerque, New Mexico.

Maheras, S. J., 1995, *Doses and Health Effects from Incident-Free INEL Onsite Non-Naval Spent Nuclear Fuel Transportation for Alternatives 1 through 5*, Engineering Design File EIS-TRANS-12, Revision 2, Science Applications International Corporation, Idaho Falls, Idaho.

Morton, D. E., and K. D. Hendrickson, 1995, "TRU, LLW, MLLW, GTCC, HazW, & IndW Generation, Storage, & Treatment Volumes," Engineering Design File EDF-94-WASTE-104, Science Applications International Corporation, Idaho Falls, Idaho, January 1995.

NAGPRA (Native American Graves Protection and Repatriation Act), 1990, Public Law 101-601.

NCRP (National Council on Radiation Protection and Measurements), 1987, *Recommendations on Limits for Exposure to Ionizing Radiation*, NCRP Report No. 91, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

National Geographic Society, 1987, *Field Guide to the Birds of North America* (second edition), The National Geographic Society, Washington, D.C.

Neuhauser, S. J., and F. L. Kanipe, 1992, *RADTRAN 4 Volume 3, User Guide*, SAND89-2370, Sandia National Laboratories, Albuquerque, New Mexico.

NIOSH (National Institute for Occupational Safety and Health), 1990, "Pocket Guide to Chemical Hazards," National Institute for Occupational Safety and Health, Washington D.C., June.

NRC (U.S. Nuclear Regulatory Commission), 1983. "Atmospheric Dispersion Models for Potential Accident Consequences Assessments at Nuclear Power Plants," Regulatory Guide 1.145, Revision 1, U.S. Nuclear Regulatory Commission, Washington, D.C.

NSC (National Safety Council), 1993, "Accident Facts, 1993 Edition," National Safety Council, Itasca, IL, page 37.

Priestly, T. B., 1992, EG&G Idaho, Inc., Idaho Falls, Idaho, records of personal communications provided to D. Brown, Advanced Sciences, Incorporated, Idaho Falls, Idaho, regarding "dBase File - Chemical Inventory Used for Preparation of SARA 312 Report for the Idaho National Engineering Laboratory."

Raudsep, J. A., 1995, Science Applications International Corporation, Idaho Falls, Idaho, letter to S. J. Connor, Halliburton NUS Corporation, Aiken, South Carolina, regarding "Toxic Pollutant Concentrations at Ambient Locations on the Idaho National Engineering Laboratory," EIS-95-JAR-0022, February 22.

Reed, W. G., J. W. Ross, B. L. Ringe, and R. N. Holmer, 1986, *Archaeological Investigations on the Idaho National Engineering Laboratory 1984-1985*, Revised Edition, Swanson/Crabtree Anthropological Research Laboratory Reports of Investigations: No. 86-4, Idaho State University, Pocatello, Idaho.

Slaughterbeck, D. C., W. E. House, G. A. Freund, T. D. Enyeart, E. C. Benson, Jr., and K. D. Bulmahn, 1995, *Accident Assessments for Idaho National Engineering Laboratory Facilities*, DOE/ID-10471, U.S. Department of Energy, Idaho Falls, Idaho, March.

USBC (U.S. Bureau of the Census), 1992, *1990 Census of Population and Housing*, U.S. Bureau of the Census, Washington, D.C.

USBEA (U.S. Bureau of Economic Analysis), 1993, *Regional Input-Output Modeling System (RIMS II), Machine-readable Regionalized Input-Output Multipliers for the INEL Region of Influence*, U.S. Department of Commerce, Washington, D.C.

Wichmann, T. L., 1994, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho, memorandum to distribution, OPE-EIS-94.171, transmitting "Methodology for Adjusting SNF Facility Accident Probabilities and Consequences for Different EIS Alternatives," March 28.

Winges, K., 1992, *User's Guide for the Fugitive Dust Model (FDM) (Revised)*, Volume I: User's Instructions, EPA-910/9-88-202R, U.S. Environmental Protection Agency, Region 10, Seattle, Washington, January.

Yuan, Y. C., S. Y. Chen, D. J. LePoire, and R. Rothman, 1993, *RISKIND - A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel*, ANL/EAIS-6, Addendum 1, Argonne National Laboratory, Argonne, Illinois.

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